PURDUE UNIVERSITY.

FIRST REPORT

OF

AGRICULTURAL EXPERIMENT STATION,

LAFAYETTE, INDIANA.

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PUBLISHED BY THE STATION:
LAFAYETTE, INDIANA, U. S. A.

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TO THE GOVERNOR OF INDIANA:

I herewith present the ANNUAL REPORT OF THE AGRICULTURAL EXPERIMENT STATION OF INDIANA, due on or before the 1st of February, 1889, the same being required by Section 3 of an Act entitled "An Act to establish Agricultural Experiment Stations in connection with the colleges established in the several States under the provisions of an Act approved July second, eighteen hundred and sixty-two, and of the Acts supplementary thereto."

Respectfully submitted,

CHARLES B. STUART,
President Board of Trustees.

Purdue University, LaFayette, Ind., January 15, 1889.

REPORT OF THE DIRECTOR.

To the Board of Control:

By an Act of Congress, entitled, "AN ACT to establish agricultural stations in connection with the colleges established in the several States, under the provisions of an Act approved July 2, 1862, and of the Acts supplementary thereto," approved March 2, 1887,

The Trustees of Purdue University were authorized and required, the State consenting, to establish an Agricultural Experiment Station at Purdue University. This Act made it the duty of the Board of Control of such Experiment Station to make an annual report to the Governor of the State in which said Station is located, on or before February 1.

In accordance with the requirements of said Act, I herewith present the First Annual Report of the Purdue Experiment Station.

EXPERIMENTAL WORK PRIOR TO JULY 1, 1887.

Purdue University was established in 1872. During the past eight years a considerable amount of experimental work has been done by the regular college professors. The principal lines of work in which they have been engaged are as follows:

Agricultural Chemistry.
Economic Entomology.
Experimental Horticulture.
Experimental Agriculture.

Although the means at our command have not been sufficient to do all that seemed desirable, or to widely distribute the results of our investigations, yet we believe that a great amount of good has been done. Detailed accounts of what was accomplished prior to July 1, 1887, will be found in our publications as follows, viz.:

SECOND ANNUAL REPORT.

1. **Analysis of Wood.**—*Wiley.*
2. **Milk Analysis.**—*Wiley.*
3. **Soil Analysis, Purdue Farm.**—*Wiley.*
4. **Water Analysis, Engine House Well.**—*Wiley.*

SIXTH ANNUAL REPORT.

5. Composition of the Sap of the Sugar Maple. Reprinted from Proceedings of American Association for Advancement of Science and from American Chemical Journal.—*Wiley.*

6. Optical Properties of Glucose.—*Wiley.*

7. Influence of Heating with Dilute Acids and Shaking with Bone Black on the Rotatory Power of Glucose.—*Wiley.*

8. Plan of Field Experiments in Agriculture.—*Ingersoll.*

Record of Meteorological Observations.—*Ingersoll.*

SEVENTH ANNUAL REPORT.

9. Cross-Fertilization of Corn.—*Ingersoll.*

Record of Meteorological Observations.—*Ingersoll.*

EIGHTH ANNUAL REPORT.

10. Estimation of Dextrose, Maltrose and Dextrine in Amylose.—*Wiley.*

11. Relation of Reducing Power, as Measured by Fehling's Solution to the Rotatory Power of Commercial Amylose.—*Wiley.*

12. Analysis of Mixed Sugars.—*Wiley and Crampton.*

13. Analysis of Fertilizers.—*Wiley and Spencer.*

14. Phosphoric Acid in Commercial Fertilizers.—*Spencer.*

15. Analysis of Sorghum Juices.—*Wiley.*

16. Clay Analyses.—*Wiley.*

17. Soil Analyses.—*Wiley and Peters.*

18. Record of Meteorological Observations.—*Ingersoll.*

19. Field Tests of Varieties of Sorghum.—*Ingersoll.*

SIXTH, SEVENTH AND EIGHTH ANNUAL REPORTS.

20. Field Tests of Varieties of Wheat, Potatoes, Grapes, Small Fruits and Fertilizers.—*Ingersoll.*

NINTH ANNUAL REPORT.

21. Report of State Chemist—Commercial Fertilizer Analyses.—*Wiley.* Reported by *Peters.*

22. Field Tests of Varieties of Wheat, Grapes, Small Fruits and Fertilizers.—*Latta.*

23. Feeding Test of Cane Seed Meal.—*Latta.*

TENTH ANNUAL REPORT.

Report of State Chemist—Commercial Fertilizer Analyses.—*Warder.*

Record of Meteorological Observation.—*Ragan.*

MONTHLY BULLETINS—Meteorological Observations published since October, 1883.—*Huston.*

ANNUAL REPORTS 1876-1883—Experiments on Farm and in the Chemical Laboratory.—*Ingersoll, Latta and Wiley.*

BULLETIN NO. 1, December, 1884—Report on the Hessian Fly.—*Webster.*

BULLETIN NO. 2, December, 1884—Report on Experiments with various Commercial Fertilizers on Corn and Potatoes.—*Latta.*

BULLETIN NO. 3, April, 1885—Report on Insects affecting Growing Wheat.—*Webster.*

BULLETIN NO. 4, September, 1885—Report on Experiments with Wheat.—*Latta.*

BULLETIN NO. 5, November, 1885—Report on Experiments with Small Fruits.—*Troop.*

BULLETIN NO. 6, March, 1886—Report on Experiments with Oats and Corn.—*Latta.*

BULLETIN NO. 7, May, 1886—Report on Experiments with Oats and Corn.—*Latta.*

Notes on Commercial Fertilizers and Agricultural Chemistry.—*Warder.*

BULLETIN NO. 8, August, 1886—Report on Experiments with Wheat.—*Latta.*

BULLETIN NO. 9, October, 1886—The American Meromyza.—*Webster.*

BULLETIN NO. 10, December, 1886—Report on Horticultural Experiment Stations.—*Troop*

BULLETIN NO. 11, May, 1887—Commercial Fertilizers.—*Warder.*

In order to increase the usefulness of the Experiment Station, an effort has been made to establish co-operative stations in various parts of the State.

At the meeting of the State Horticultural Society held in LaFayette, December, 1885, an agreement was entered into between the Society and the Board of Trustees of Purdue, by which a number of co-operative Horticultural Stations were to be established in various parts of the State, all of which were to be under the general management of the Purdue Station.

In pursuance of this plan, the following stations were organized, under the direction of Prof. Troop, viz.:

Bartholomew County, Columbus—Manager, A. Glenn.
Cass County, Logansport—Manager, L. B. Custer.
Clay County, Ashboro—Managers, J. T. Moss & Sons.
Floyd County, New Albany—Manager, Jonathan Beard.
Gibson County, Princeton—Manager, E. H. Hallett.
LaGrange County, Haw Patch—Manager, J. N. Latta.
Marion County, Indianapolis—Manager, A. G. Chandlee.
Randolph County, Winchester—Manager, D. E. Hoffman.
Union County, Lotus—Manager, Edwin Gardner.
LaPorte County, LaPorte—Manager, W. Wier.

The prime object for which these co-operative stations were established was for the purpose of making a thorough and careful test of new fruits, plants and vegetables, as far as possible, before they are put upon the market, in order to ascertain, if possible, which are really worthy of cultivation in the different portions of the State.

Our TENTH BULLETIN, published in December, 1886, gives a detailed account of the operation of these stations for the year then ending.

During the past three years, also, several co-operative stations were established for the purpose of agricultural experimentation, under the direction of Prof. Latta. They were as follows, viz.:

Bartholomew County—Farm of W. E. Moffatt.
Boone County—Farm of James Riley.
Henry County—Farm of J. B. Hearkless.
Noble County—Farm of J. N. Latta.
Ripley County—Farm of S. M. Saltmarsh.
Tippecanoe County—Farm of Robert McKee.
Wayne County—Farm of Walter S. Ratliff.

Detailed reports of the results of this experimentation will be found in Bulletins Nos. 8 and 12.

In addition to these, five stations have been established by Prof. Webster, for the purpose of affording means for a special study of the ravages of the Hessian Fly. They were as follows, viz.:

LaGrange County—Farm of J. N. Latta.
LaPorte County—Farm of W. A. Banks.
Parke County—Farm of Miles Martin.
Wayne County—Farm of Walter S. Ratliff.
White County—Farm of Samuel Hargrove.

Valuable information has already been received; enough to warrant us in saying that when the investigation is completed, we shall be able to afford information to the farmers of the State of the highest economic value.

EXPERIMENTAL WORK FROM JULY 1, 1887, TO DEC. 31, 1887.

The bill establishing the Purdue Experiment Station required the Trustees to organize it July 1, 1887, but through a technical defect in the Act of Congress, the appropriation necessary therefor was not made immediately available. The Trustees, however, decided to go on with the experimental work from and after July 1, 1887, and also to make active preparations for the more thorough organization of the Station when the money from the Congressional grant should become available.

The organization of the Station from July 1, to December 31, 1887, was as follows, viz.:

William C. Latta, M. S. Experimental Agriculture.
James Troop, M. S. Experimental Horticulture.
Henry A. Huston, A. M., A. C., Meteorology.
Francis M. Webster, Economic Entomology.

These gentlemen spent a part of their time only in experimental work, the remainder being spent in college work. The work accomplished during this period was satisfactory. Prof. Latta was chiefly engaged in preparation for a wider range of experimentation during the coming agricultural season. He, however, brought out his Bulletin No. 12, August, 1887, which gave a detailed account of the experiments with wheat, including tests of varieties, rates of seeding, mulching, cultivation, commercial fertilizers, etc.

Prof. Troop gathered up the results of the year's work in the ten co-operative Horticultural Stations, and made a special report thereon to the State Horticultural Society, and at the same time did considerable work in improving and enlarging the Home Horti-

cultural plats. Prof. Huston published six Meteorological Bulletins. Prof. Webster is connected with the United States Bureau of Entomology, and makes his reports directly to the Department at Washington. He, however, continues his investigations concerning the ravages of the Hessian Fly. The result will be published in future bulletins.

Expenses for the maintenance of the Station from the 1st of July, 1887, to December 31, 1887, were provided for by temporary drafts on the University funds. This amount was subsequently returned to the University treasury by a transfer warrant against the Station treasury.

REPORT FOR THE YEAR ENDING DECEMBER 31, 1888.

It becoming apparent, about the 1st of December, 1887, that the money due for the fiscal year ending June 30, 1888, would be made available at an early date, the Trustees decided to thoroughly reorganize the Station force, and to make the needed preparation for the most active work.

Section 2 of the law reads as follows, viz.:

"That it shall be the object and duty of said Experiment Stations (1) to conduct original researches or verify experiments on the physiology of plants, and (2) animals; the diseases to which they are severally subject, with the remedies for the same; (3) the chemical composition of useful plants in their different stages of growth; (4) the comparative advantages of rotative cropping as pursued under a varying series of crops; the capacity of new plants and (5) trees for acclimation; (3) the analysis of soils and water; the chemical composition of manures, natural or artificial; with (4) experiments designed to test their comparative effects on crops of different kinds; (4) the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific economic questions involved in the production butter and cheese; (4, 5 and 6) such other researches or experiments bearing directly upon the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States or Territories."

It will be observed that paragraph one suggests a botanist; two, a veterinarian; three, a chemist; four, an agriculturist, and five, a horticulturist.

The great destruction of our crops occasioned by the ravages of injurious insects made it important, also, that an entomologist be connected with the Station.

In accordance with this view, the following Station Staff was organized January 1, 1888:

Jas. H. Smart, LL. D., *Director pro tem.*
Wm. C. Latta, M. S., *Agriculturist.*
Henry A. Huston, A. M., A. C., *Chemist.*
Joseph C. Arthur, D. Sc., *Botanist.*
Jas. Troop, M. S. *Horticulturist.*
Francis M. Webster, U. S. Department Entomology, *Entomologist.*
Theries D. Hinebauch, M. S., V. S., *Veterinarian.*
Pierre Van Landeghem, *Florist.*
Carl A. Wulff, M. S., was appointed *Assistant Director* on September 1st, 1888.

EQUIPMENT.

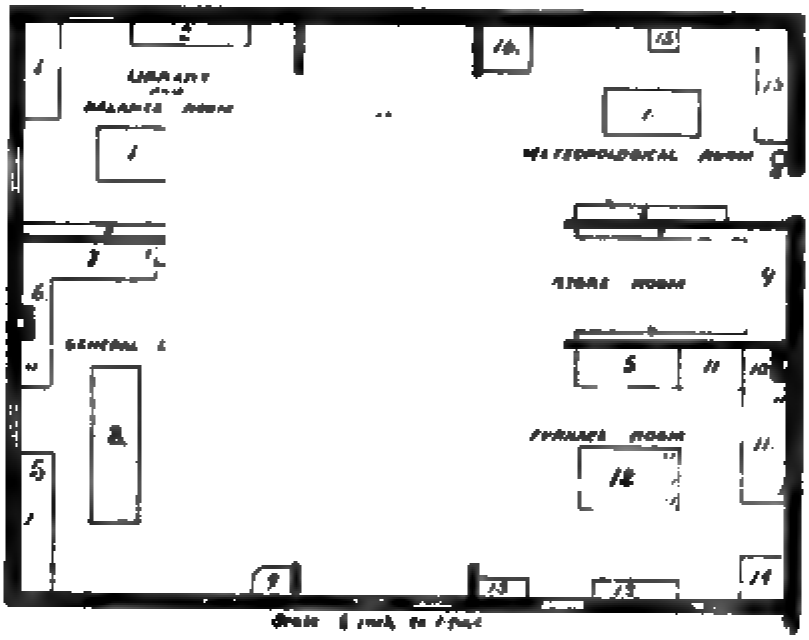
The University turned over to the Station its Agricultural Hall, a building which now forms the east wing of the present Station building, and a farm of about 160 acres, with its farm-house, storage and stock-barn, six head of horses, ten head of cattle, and a great variety of farm machines and implements, the property being worth forty thousand ($40,000) dollars. The Agricultural Hall was converted into a Chemical Laboratory, an Entomological Laboratory, an office for the Horticulturist, and a room for experimental work in dairy products. An addition to the hall was completed early in June, which provided accommodations for the Botanist, for the Station Library, an office for the Director, and a Museum, and several rooms for other purposes.

The building is supplied with water and is heated by steam. These additional permanent improvements cost about six thousand ($6,000) dollars, three thousand ($3,000) dollars of which was drawn from the first year's congressional grant as provided for by Section 5 under the Act making an appropriation.

The Chemical Laboratory includes five rooms on the second floor of the east wing of the Station building. The rooms have been especially designed to afford facilities for rapid work in the analysis of agricultural material and products, such as fertilizers and fertilizing material, soils, drainage waters, cattle foods, dairy products, sugar-producing plants, etc. Two rooms are available for special work that needs to be removed from the general working laboratory.

The rooms are provided with gas, water, air pumps and blast lamps worked by water pressure, and the entire equipment is new and of the most approved kind.

The office of the weather service is on the same floor, and is frequently utilized in the comparison of instruments and for final measurements in gas analysis.



Plan of Chemical Laboratory.—Second Floor, East Wing.

1. Writing desks.
2. Balances.
3. Book cases.
4. Sample shelves.
5. Chemical tables.
6. Hood.
7. Extraction table.
8. Table for special apparatus.
9. Storage shelves and case.
10. Links.
11. Furnaces.
12. Table for glass-blowing.
13. Tituration tables.
14. Assay Plate.
15. Meteorological instruments.
16. Meteorological charts.
17. Air pumps and blasts.

The Library of the Chemical division includes full sets of *Liebig's Annalen*, *Fresenius*, *Zeitschrift für Analytische Chemie*, *Journal of the Chemical Society*, *Watt's Dictionary*, and other standard and special works.

THE BOTANICAL LABORATORY occupies a floor space of twenty by forty-eight feet on the ground floor, divided into five rooms very compactly arranged for convenient use. The general laboratory is twenty feet square, from which the other rooms open to the right and left.

No laboratory for botanical work is satisfactory without ample, but not too bright light: conditions perfectly met in the main room by a large triple window looking toward the south. The intensity of the light is readily modified by white Holland shades, to intercept the direct sunshine, and by heavy drop curtains to regulate the general light of the room. Under this large window is a shelf, supported from the wall to escape jarring, providing room for

three or four microscope workers at a time. On the west side of the room are desks, much after the pattern of desks in chemical laboratories. These are provided with gas, water and aspirators, and stocked with suitable apparatus in glass and metal. They are chiefly used for physiological experiments on the growth and development of plants. A large table in the center of the room and other smaller tables are designed for special uses. A wall case contains several dozen kinds of reagents for micro-chemical tests. Over a sink at one side of the room is a device for aerating the water in several glass jars, in which water-plants are grown for experimental purposes, and also an apparatus for giving a stream of hot water whenever desired.

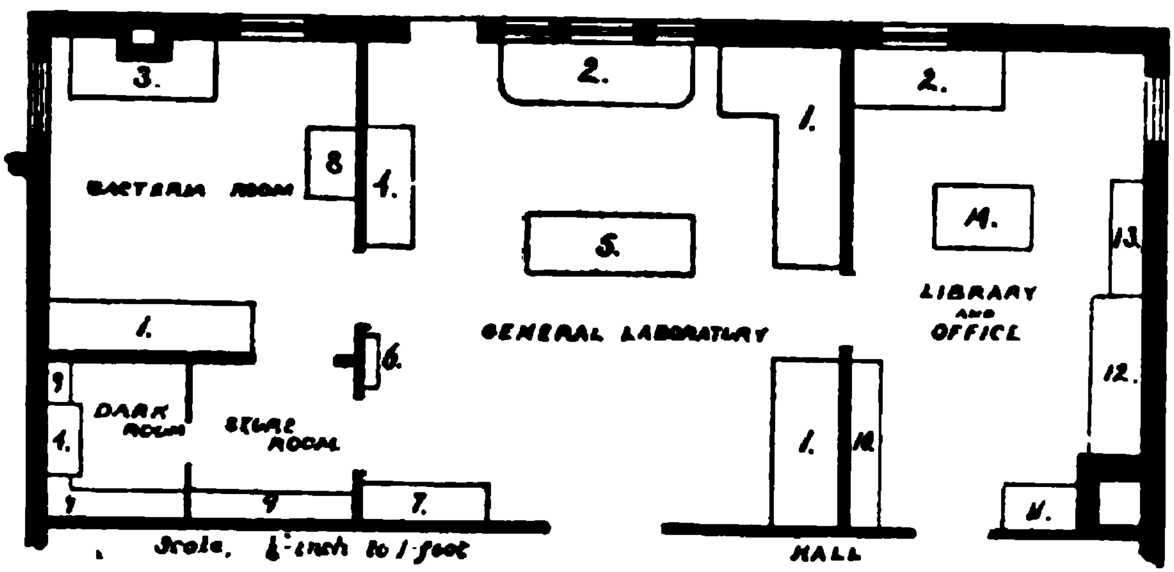
Opening from the general laboratory is the bacteria room, in which special work in bacteriology is carried on, particularly upon the germ diseases of plants. A good-sized hood carries off all noxious vapors, steam, etc.; a refrigerator provides the means for keeping putrescible substances for experimental uses, and a working desk has water, gas and other conveniences. The special apparatus of this room consists of dry and moist sterilizers, and two fine pieces of apparatus for growing germs at a constant temperature, all of which are from the latest designs of Dr. Koch, the renowned German bacteriologist, and were imported from Berlin. Flasks, cultivation tubes, moist chambers, and other apparatus, brought into use by Pasteur, Recklinghausen, Brefeld, Sternberg, and other noted investigators, have been provided.

Opening from both the general laboratory and the bacteria room, is a small store-room, and beyond this a dark room for photographic and other purposes. The dark room has an outfit of the usual appliances for developing and finishing photographic negatives and prints.

The department is also fitted with cameras for both instantaneous and time exposures, and for plates ranging from the smallest up to eight by ten inches. Photographs may be taken from the microscope, or from large objects. For the examination of minute objects, such as germs and various kinds of fungi, an excellent microscope has been obtained, fitted with the best lenses made by Zeiss, Spencer, and Bausch & Lomb. This instrument can also be adjusted for making photo-micrographs.

On the west side of the general laboratory is the office and library. Here is the botanical part of the Station's library, and

also the herbarium. A case is provided for fine instruments, used in the general laboratory, but kept here for greater safety. A desk at one of the windows is arranged for special microscopic work. A card catalogue table and writing desk complete the larger pieces of furniture.



Plans of Botanical Rooms.

1, 1, 1. Desks with shelves above and drawers below.
2, 2. Microscope tables.
3. Hood. 4, 4. Sinks.
5. Working table.
6. Reagent case.
7. Photographic apparatus.
8. Refrigerator.
9, 9, 9. Shelving.
10. Book case.
11. Catalogue table.
12. Herbarium case.
13. Case for fine instruments.
14. Writing desk.

This comprises the chief features of the rooms and furnishings of the botanical department as it now stands. It is proposed, in order to have growing plants at all seasons of the year for experimental use, to add a greenhouse to the laboratory, provided with some special arrangements for adjusting the temperature and moisture to the requirements of different plants and different experiments. A vegetation house of glass is also contemplated, intended for more perfect out-door experiments during the warm part of the year, especially designed for studying the relation of soils and fertilizers to the production of maximum crops.

THE STATE WEATHER SERVICE.

The Station is the headquarters of the State Weather Service. This consists of between thirty and forty observing-stations and about one hundred and forty flag-stations. The persons in charge of the former are provided with instruments furnished to the service by the United States. The observers send to the Central Station monthly weather reports, and during the growing season, weekly

crop weather reports. A monthly weather report, containing a review and summary of the individual reports, and a comparative table, covering a period of several years, is distributed. The weekly crop weather reports are also distributed during the season.

The service sends out about one hundred and forty telegrams daily, Sundays excepted, to flag-stations in various parts of the State. The flags for these stations are provided by local enterprise; they are displayed each morning and give the ordinary weather indications.

The monthly bulletins have both a practicable and permanent scientific value. It is the intention to extend all parts of the service as rapidly as our means will allow, and the crop weather reports and the flag service have a practical bearing upon many branches of business.

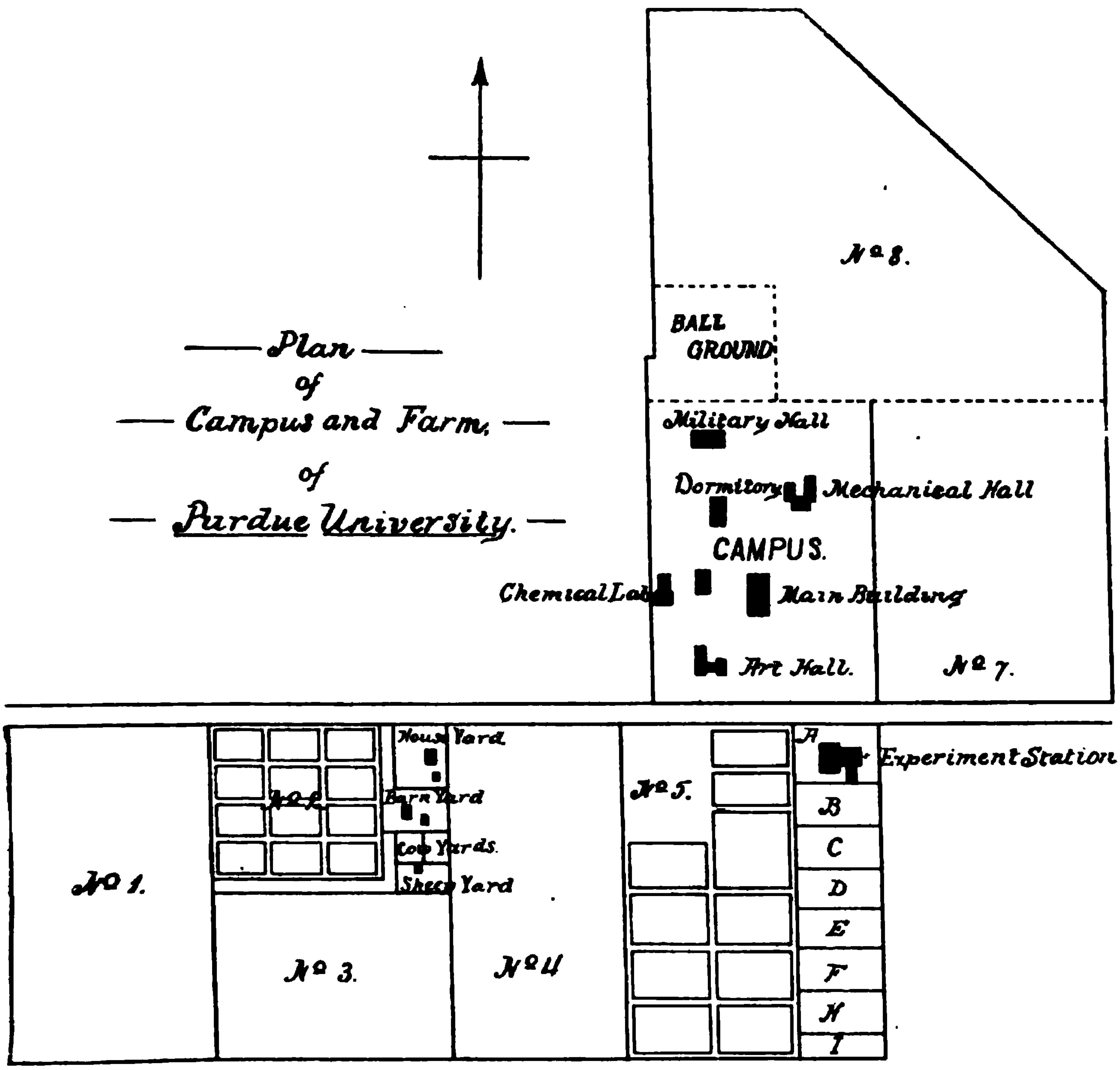
The State Weather Service was planned and inaugurated by Hon. John B. Conner, former State Statistician. He has maintained an active interest in the work, and to him great credit is due for its present efficiency. The Station is also under many obligations to the observers who so kindly furnish reports, and to the Signal Service of the Army for assistants, instruments, stationery, telegraphing, etc.

THE WORK OF THE SEASON, 1888.

It was the evident intention of the framers of the law that the Experiment Station should give special attention to such phases of agricultural experimentation as have a high economic value, and to such, also, as could not well be performed by farmers themselves.

While some experiments may be in their nature immediately conclusive, it must nevertheless be remembered that scientific agricultural investigation requires much time and repeated verification. Hasty conclusions are misleading, and are sometimes followed by disastrous results. Too much, therefore, should not be expected of a Station during the first two or three years of its existence. Much time has necessarily been spent in fitting up the laboratories, in selecting material, and in setting up and arranging apparatus; nevertheless, progress has been made in all the departments. In all, eight regular bulletins have been prepared during the year. Five of these have been printed and three are in press. They are as follows:

Plan of Campus and Farm of Purdue University.



No. 1.	Fields devoted to crops in following order:
No. 3.	1st and 2d year, Grass and Clover.
No. 4.	3d year, Corn.
No. 7.	4th year, Oats.
No. 8.	5th year, Wheat.
No. 2.	Horticultural Plats.
No. 5.	New Permanent Experiment Plats.
B-I.	Old Experiment Plats.

BULLETIN No. 13, January, 1888—Report on New Organization.—*President Smart.*
BULLETIN No. 14, April, 1888—Report on Experiments with Oats and Corn.—*Latta.*
BULLETIN No. 15, June, 1888—Report Concerning the Potato Tuber.—*Arthur.*
BULLETIN No. 16, August, 1888—Report on Experiments with Wheat; Crop Rotations.—*Latta.*
BULLETIN No. 17, November, 1888—Report on Parturient Apoplexy.—*Hinebauch.*
BULLETIN No. 18, January, 1889—Report on Experiments with Vegetables.—*Troop.*
BULLETIN No. 19, January, 1889—Report on Spotting of Peaches and Cucumbers.—*Arthur.*
BULLETIN No. 20, January, 1889—Report on Experiments in Cross-Fertilization, and the Culture of Tropical Ferns.—*Van Landeghem.*

Besides these, twelve Weather Service Bulletins and thirty-three Crop Weather Reports have been published and distributed. The Chemical Department has been busily engaged in making a complete soil analysis of our agricultural plats. This is a work which will require several months for its completion, and no report of the result can be made at present.

For the benefit of those who are specially interested in field work in agriculture, I herewith present special reports by the Agriculturist and the Horticulturist of the Station. The results of the work in the other departments will be found in the Bulletins indicated above.

REPORT OF THE AGRICULTURIST.

President J. H. Smart:

SIR: The report of the Agricultural Department, herewith submitted, covers the time from the organization of the Experiment Station under the "Hatch Act," July 1, 1887, to January 1, 1889. The department has been chiefly occupied in conducting field experiments previously begun. Some attention has been given to laying out and preparing for new lines of experiment, both in field and stall; and a considerable portion of the time of the Agriculturist has been given to the general work of the Station.

FIELD EXPERIMENTS OF 1887 AND 1888.

During the seasons of 1887 and 1888 experiments have been continued in testing varieties of wheat, oats and corn; rates and dates of planting and seeding; methods of preparing the ground, and of planting, sowing and cultivating; effect of previous manuring on yield of corn; effects on soil and crop of various systems of cropping without manures.

Within the time stated above, the department has sent out three bulletins: No. 12, August, 1887, "Experiments with Wheat;" No. 14, April, 1888, "Experiments with Corn and Oats;" No. 16, August, 1888, "Experiments with Wheat with Notes on Crop Rotations." Material is now about ready for a report on Experiments with Corn and Oats in 1888.

NEW EXPERIMENT PLATS.

Early in September, 1888, about twelve acres were laid out in plats in field No. 5, which lies just west of the present experiment field. The plats are laid out with interspaces and surrounding borders so that each one is isolated from the others. Each plat is 14⅔ feet wide by 297 feet long, and contains exactly one-tenth acre. The interspaces are just half the width, and hence, half the area of the plats. To secure permanence of location a piece of galvanized iron pipe, four feet long, was driven almost its entire length into the ground at each corner of every plat. The plats were staked off in sets of five or seven—with one exception to be mentioned—and each set is surrounded by a border 7⅓ feet wide along the ends, and 14⅔ feet wide along the sides of the set. Outside the border is a driveway extending entirely around each set of plats. The design is to devote to crops, not only the plats, but the interspaces and surrounding borders as well, so that no plat will have any outside exposure. The driveways will give access to, and permit work upon, any set of plats without disturbing any other set. Owing to the small size of the sets, it will be possible to perform the operation of planting or cultivating, or harvesting or weighing, etc., on all the plats of a set in a single day, which will largely eliminate variations in results due to difference in time of treating the plats. The purpose is to devote eight sets, comprising fifty-two plats, to tests of various systems of cropping with and without manures, in order to demonstrate and illustrate the effects of good and bad methods of farming on soil, and on quality and yield of crops. From one set of plats, soil samples for analysis were taken to the depth of over four feet in September, 1888.

Late in the same month this set was seeded to wheat, which crop will be grown continuously in the same place for years. Samples of soil for analysis will be taken from the remaining sets in the spring of 1889, at which time the new system of cropping will

begin. One set of seventeen plats, of the same dimensions as those referred to above, and arranged in the same way, will be devoted to a test of partial and complete fertilizers continuously applied, for the purpose of determining their effects on soil and crop.

FEEDING EXPERIMENTS.

Some feed-preparing machinery and dairy apparatus have recently been added to the farm equipment. These additions will be utilized during the coming winter in conducting a combined feeding and dairy experiment. It is the intention of those in charge to make the experiment decisive, so far as a single test may be, on the questions involved. The test, however, must of necessity be accommodated to our present inconvenient and ill-adapted quarters.

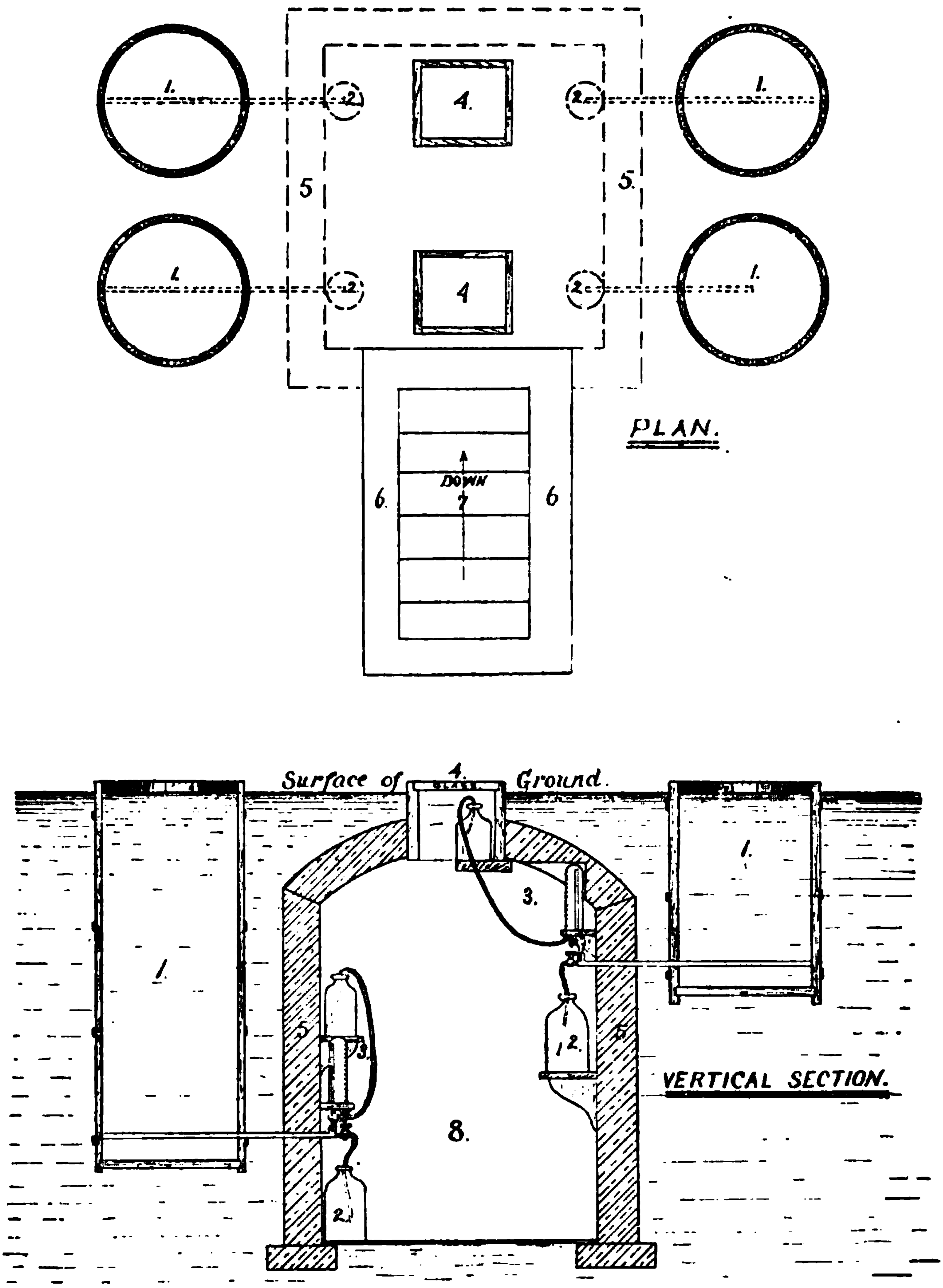
In order to take up feeding and dairy experiments on a scale commensurate with their importance, it is absolutely necessary to have a barn, dairy-house, and additional appliances adapted to such work.

LYSIMETERS.

Four lysimeters, modeled after the new set of the New York Agricultural Experiment Station, at Geneva, were put in place early in December, 1888. They are so constructed as to make it possible to measure and record the losses of water by drainage and by evaporation; and an analysis of the drainage water will show the losses of soil fertility from this cause.

As few people have ever seen a lysimeter, a brief description of the Station set will be proper. Each lysimeter-box, when finished, resembles, somewhat, a hogshead with one end open. The sides, however, have but a slight bilge or swell on the outside and are perfectly straight inside. The sides and bottom are constructed of oak and lined with sheet-copper carefully soldered at all the joints so as to be water-tight. Within six inches of and parallel to the bottom of each box is a perforated copper tube, which extends entirely across the lysimeter, and, passing through one side, connects the box with an under-ground vault, in which the observations are taken. These tubes give an outlet to the drainage-water, and also subserve another purpose to be explained later.

The above remarks apply to the lysimeters when finished and placed in the soil beside the vault. Now as to filling with soil. Two lysimeters, one 3⅔ feet and the other 6⅔ feet deep, were



Scale, ¼ inch to one foot.

Ground plan and vertical section of lysimeters and vaults showing position of the apparatus.

1, 1, 1, 1, Lysimeters.
2, 2, 2, 2, Receiving bottles.
3, 3, Supplying apparatus.
4, 4, Skylights.
5, 5, 5, 5, Wall of vault.
6, 6, Brick walls.
7, Entrance Steps.
8, Vault.

carefully adjusted in place as above described. First six inches of fine sand, sifted and washed, and put into each box, thus filling them to the level of the drain-tubes. Then fine, sifted surface soil was put in to the depth of three and six feet respectively, which made one pair of lysimeters complete, and left two inches of the boxes projecting above the contained and surrounding soil, so that each one would receive exactly its own share of the rain-fall and no more.

The filling of the other pair—which were of the same size as the first two—was a far more difficult process. Before attaching the bottoms and drain-tubes, as in the first pair, the boxes, in the form of hollow cylinders, were sunk around vertical columns of soil in place, thus avoiding any disturbance of the strata. The shorter box was sunk in this way within two inches of its entire length. It was then inverted and six inches of the sub-soil removed, when the drain-tube and sand were put in, and the bottom securely soldered and fastened in place. The lysimeter was then turned right end up and placed in position beside the vault. The longer box was settled in the same way through about 3½ feet of earth, when loose gravel was reached, which prevented, by friction on the side of the box, further settling. The box was then inverted, the enclosed column of earth brought to its proper position at the upper (now lower) end of the cylinder, and the loose gravel of the lower sub-soil filled in, when the drain-tube was inserted, the sand put in and the bottom secured as before; after which the lysimeter was righted and placed beside the vault. The purpose of the sand in the bottom of each lysimeter, is to afford a porous stratum in which free water may collect and rise to the level of the perforated copper tube, which would prevent any further rise by conveying the surplus into the vault as drainage-water. The soil above the tube will therefore be constantly drained, and the sand below constantly saturated, unless the water be drawn up by the capillary action of the soil, as the result of evaporation from the surface.

An ingenious device within the vault will, by a self-acting arrangement, allow water to flow back through the drain-tube into the lysimeter to take the place of that lost by evaporation, and thus maintain the level of free water just below the drain outlet. By means of graduated tubes, the water thus flowing back, as well as the drainage-water, will be accurately measured.

It will be observed that the lysimeters approximately represent tile-drained land, with the tile three feet below the surface in one case, and six in another, with free water just below the line of the tile. It seems probable, therefore, that the losses of water, by drainage and evaporation, from the lysimeters will indicate approximately these losses in the open field of a similar soil, and drained to a corresponding depth.

With the addition of a sunshine recorder and self-recording thermometer, the Station will be enabled to keep a record of the weather, and of soil processes, that will, in time, prove of great practical value to agriculture.

I take pleasure in acknowledging the courtesy and assistance of Mr. E. S. Goff, Horticulturist of the New York Experiment Station, who kindly supervised the construction of the lysimeter boxes and recording apparatus for this Station, and sent carefully-drawn plans and explicit instructions for constructing the vault, and for filling and placing the lysimeters.

Very respectfully submitted,

W. C. LATTA, *Agriculturist.*

REPORT ON CO-OPERATIVE HORTICULTURAL STATIONS.

President J. H. Smart:

SIR: I submit the following brief report concerning the ten co-operative Horticultural Stations that were established in various parts of the State and placed under my supervision.

My work has been necessarily limited to a few lines—chiefly to the testing of new and untried fruits and vegetables. The Stations have not been in existence long enough to enable me to state with any great degree of accuracy the results. I therefore limit my report to a statement concerning the organization of the Stations.

The managers of the Sub-stations were required to sign an agreement not to propagate or distribute any plant not in market, but to faithfully test all varieties sent for trial, and report results to the University at least once a year, and oftener, if required.

These Stations are located in different parts of the State, and are managed by the following persons:

A. G. Chandlee, Indianapolis, Marion County.
J. T. Moss & Sons, Ashboro, Clay County.
Jonathan Beard, New Albany, Floyd County.

Horticultural Experiment Plat, Ten Acres.—Explanation of Diagram.

A, Strawberries.
B, Currants and gooseberries.
C, Raspberries and blackberries.
D, Grapes.
E, Arboretum.
F, Peaches.
1, 1, Plums.
2, 2, Cherries.
3, 3, Pears.
o, o, o, Apples.

E. H. Hallett, Princeton, Gibson County.
A. Glenn, Columbus, Bartholomew County.
A. L. Folger, Manilla, Fountain County.
L. B. Custer, Logansport, Cass County.
D. E. Hoffman, Winchester, Randolph County.
J. N. Latta, Haw Patch, LaGrange County.
Wier Bros., LaPorte, LaPorte County.

A large portion of the small fruit plants distributed to the Stations were donated by the orginators, while the trees were nearly all purchased from Prof. J. L. Budd, of Iowa.

The number of plants and trees now on trial at the different Stations are as follows:

No. 1. A. G. CHANDLEE, *Manager*.

7 Varieties apple (Russian.)
1 Variety peach.
1 Variety blackberry.
14 Varieties strawberry.
1 Variety pear (Russian.)
4 Varieties plum.
3 Varieties raspberry.
3 Varieties currant.

No. 2. J. T. MOSS & SONS, *Managers*.

7 Varieties apple (Russian.)
1 Variety plum.
1 Variety apricot.
4 Varieties currant.
1 Variety pear (Russian.)
1 Variety peach.
2 Varieties raspberry.
8 Varieties strawberry.

No. 3. JONATHAN BEARD, *Manager*.

5 Varieties apple (Russian.)
2 Varieties cherry (Russian.)
3 Varieties currant.
1 Variety blackberry.
1 Variety pear (Russian.)
4 Varieties plum.
2 Varieties grape.
8 Varieties strawberry.

No. 4. J. N. LATTA, *Manager*.

5 Varieties apple (Russian.)
4 Varieties plum.
3 Varieties raspberry.
3 Varieties pear (Russian.)
1 Variety currant.
5 Varieties strawberry.

No. 5. D. E. HOFFMAN, *Manager*.

4 Varieties apple (Russian.)
3 Varieties plum.
1 Variety peach.
1 Variety gooseberry.
4 Varieties raspberry.
12 Varieties strawberry.
3 Varieties pear (2 Russian, 1 Peffer's No. 3.)
3 Varieties currant.
2 Varieties grape.
2 Varieties blackberry.

No. 6. L. B. CUSTER, *Manager*.

7 Varieties apple (Russian.)
4 Varieties plum.
1 Variety gooseberry.
2 Varieties blackberry.
10 Varieties strawberry.
1 Variety pear (Russian.)
2 Varieties currant.
1 Variety grape.
5 Varieties raspberry.

No. 7. A. L. FOLGER, *Manager*.

6 Varieties apple (Russian, 1 Indian.)
2 Varieties plum.
3 Varieties currant.
2 Varieties raspberry.
13 Varieties strawberry.
2 Varieties pear.
1 Variety peach.
2 Varieties gooseberry.
1 Variety blackberry.

No. 8. E. H. HALLETT, *Manager*.

5 Varieties apple (Russian.)
2 Varieties pear (Russian.)
3 Varieties plum.
1 Variety peach.
1 Variety currant.
2 Varieties grape.
3 Varieties raspberry.
2 Varieties blackberry.
11 Varieties strawberry.

No. 9. A. GLENN, *Manager*.

8 Varieties raspberry.
6 Varieties blackberry.
2 Varieties gooseberry.
2 Varieties currant.
11 Varieties strawberry.
12 Varieties cherry.
2 Varieties pear.

No. 10. WIER BROS., *Managers*.

2 Varieties raspberry.
2 Varieties blackberry.
8 Varieties strawberry.
3 Varieties currant.

No. 10 was not located till last Spring, 1888.

Very respectfully submitted,

JAMES TROOP, *Horticulturist*.

CONCLUSION.

I conclude by quoting a few paragraphs from our Thirteenth Bulletin, as follows:

"Attention is called to the fact that while, in order to make our work effective, we must, within a limited period of time, concentrate our efforts upon a few lines of work, we can and ought, during an extended series of years, to give attention to a great variety of subjects. We must experiment with new varieties of grain, grasses and fruits, for the purpose of securing a better quality and a larger yield. We must try to find out the best methods of seeding. We must experiment in regard to the adaptability of soils to the various crops, and in regard to crop rotation, the use of fertilizers, and the gathering, curing and preservation of farm products. We must experiment upon the best methods of feeding and taking care of stock, and upon the production of butter and cheese.

"Among the most important subjects with which the Station will have to deal are those which are connected with the exhaustion and the renovation of the soil.

"We are beginning to realize the enormous destruction of values every year through soil deterioration. We are beginning to find out that nature will not be cheated. We can not expect the soil to respond with a continued harvest, if subjected to constant robbery. Taking money out of the soil and putting it into a bank may make rich farmers, but it will be likely to make poor sons. The safest bank of deposit for a farmer is his farm.

"There is another field of investigation which is of the highest economic value to the State, and one which must be occupied as fast and as far as possible, if the Station is to accomplish its purpose. The question how to produce larger and better crops is an important one, but the question how to prevent the enormous destruction of grains, fruits, and of domestic animals through disease, is also an important one. Millions of dollars are lost in Indiana every year by improper methods of cultivation, millions by fungus diseases, and millions by insect ravages. It is estimated that in the United States the loss from insect ravages alone amounts to three hundred millions of dollars annually."

President Adams, of Cornell, in a pamphlet published in 1886, entitled, "A Plea for Scientific Agriculture," says:

"In New York the crop of wheat went down in twenty years from 13 bushels per acre to 10.3 bushels per acre; of corn, from 29.3 to 23. Going to the South, we find that in North Carolina during the last ten years—for there were no figures during the war—the crop of wheat has declined from 8 bushels to 5.9 bushels per acre; corn, from 16.4 to 11.5; oats, from 12.9 to 8.7. In Georgia the crop of wheat fell from 7.3 to 5.1; corn, from 11.1 to 8.7; oats, from 10.2 to 9. In Mississippi—wheat, from 9.2 to 5; corn, from 13.8 to 13.5; oats, from 14.5 to 11.5. In Texas, wheat fell from 12.5 to 8.5; corn, from 19 to 18.5; oats, from 27.2 to 22.8 Coming back to the North and Northwest, we find in Kentucky, from 1864 to 1884, the product of wheat declined from 10.2 to 7.7 bushels per acre; corn, from 28.5 to 24; oats, from 24.2 to 16.3 In Indiana—wheat, from 14.3 to 10.4; corn, from 29 to 27. In Illinois, wheat went down from 14.3 to 10, and corn from 33 to 25. And so not to weary you with these depressing figures, it is enough to say that although, as already said, there is not an absolute uniformity of diminution, yet the general diminution is unmistakable. If we take an average of the three years, 1863, '64 and '65, on the one hand, and for the three years, 1882, '83 and '84, on the other, we shall find that in all of the staple crops there has been a very marked diminution of products per acre."

As he justly remarks, "These facts are depressing, if not startling." It may not be possible to make two blades of grass grow where one grew before, but it is possible to stop this enormous

wastage, and to largely increase the annual yield of agricultural products, and to improve their quality. The history of experimental agriculture in the Old World proves this to be true. The experience of Germany is not only very instructive, but very encouraging. I am indebted to President Adams again for this extract:

"Much of Prussia, a hundred years ago, was little better than a vast plain of sand, and a considerable portion of it was swamp, given up to wolves and bears. Very much of it was regarded as absolutely irreclaimable. The climate is cold and damp, and is unfavorable to the securing of the best results. But under this system of industry, the bad lands have been reclaimed, and the sandy plains have been brought into abundant fertility. Not only has the production, per acre, been increased by nearly two-fold in all parts of the Empire, but the forests have been carefully preserved, and even extended; variety has been added to the lists of products, and the number of acres in tillage has been multiplied. The list of plants, now grown with profit in Germany, is far greater than it was half a century ago, and some of them, as for example, the sugar beet, are adding annually enormous sums to the wealth of the Empire. Thus it is that Germany receives an unbounded and constantly increasing reward for the care which she has bestowed upon the culture of the soil."

How has this been brought about? The sufficient answer to this question is, that the German Government sustains over one hundred and fifty agricultural colleges and experiment stations, and that these are all richly endowed with laboratories, museums, libraries, experimental farms, and the ablest scientific investigators to be found in the Empire.

If the Purdue Station should be able, through its experiments, to make every dollar's worth of our farm products worth one dollar and one cent, or if we can add one per cent. to the annual yield, it will be worth three millions of dollars annually to the State. It is safe to say that it is quite possible to increase the value of the agricultural products of Indiana twenty-five per cent. without increasing the area under cultivation. This would produce a total annual increase of values to the amount of $75,000,000.

I trust that nothing more need be said to interest the farmers of Indiana in the work of the Purdue Experiment Station.

Respectfully submitted,

JAMES H. SMART, *Director pro tem.*

The Agricultural Experiment Station, of Indiana, in account with the United States—Year ending June 30, 1888.

Dr.		
To Appropriation		$15,000 00
Cr.		
By Salaries of Staff	$ 3,312 50	
Labor	2,057 75	
Care of buildings	17 95	
Supplies and repairs	1,119 68	
Apparatus and fixtures	2,648 85	
Books and periodicals	1,640 67	
Printing and stationery	472 69	
Express and freight	96 16	
Postage	7 46	
Traveling expenses	205 10	
Clerical work	95 50	
Permanent building	3,000 00	
Stock	176 25	
Sundries unclassified	62 35	
Balance unexpended	87 09	
	$15,000 00	
		$15,000 00

The above is a correct statement of the receipts and expenditures of the United States Government Fund of the Agricultural Experiment Station, of Indiana, as taken from the books of the Registrar by me.

M. C. STEVENS,
Secretary of the Board of Trustees.

Additional Receipts and Expenditures.

Dr.		
To Receipts of products sold from Experiment Farm		$945 66
Cr.		
By Expenditures on Experiment Building	$464 10	
Laying water pipes to building	171 20	
Fixtures	46 28	
Balance unexpended	264 08	
	$945 66	
		$945 66

The above is a correct statement of the Special Fund of the Agricultural Experiment Station, of Indiana, as taken from the books of the Registrar.

M. C. STEVENS,
Secretary of the Board of Trustees.

THE

FIFTEENTH REPORT

OF

Purdue University,

THE SAME BEING FOR THE

Year Ending June 30, 1889,

DING

Second Report of Agricu ment Station, LaFayette Ind, for the Year Ending June 30, 1889

TO THE GOVERNOR.

INDIANAPOLIS
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING
[illegible]

THE

FIFTEENTH REPORT

OF

Purdue University,

THE SAME BEING FOR THE

Year Ending June 30, 1889,

INCLUDING

Second Report of Agricultural Experiment Station, Lafayette, Ind., for the Year Ending June 30, 1889

TO THE GOVERNOR.

THE

FIFTEENTH REPORT

OF

PURDUE UNIVERSITY,

THE SAME BEING FOR

THE YEAR ENDING JUNE 30, 1889.

TO THE GOVERNOR.

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.
1890.

PURDUE UNIVERSITY BUILDINGS

LAFAYETTE, IND.

STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
INDIANAPOLIS, February 1, 1890.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statements.

OFFICE OF AUDITOR OF STATE,
INDIANAPOLIS, February 1, 1890.

The financial part of the within report, so far as it relates to money drawn from the State Treasury, has been examined and found correct.

BRUCE CARR,
Auditor of State.

Returned by the Auditor of State, with the above certificate, and transmitted to the Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

W. B. ROBERTS,
Private Secretary.

Filed in the office of the Secretary of State of the State of Indiana, February 1, 1890.

CHARLES F. GRIFFIN,
Secretary of State.

BOARD OF TRUSTEES.

OFFICERS OF THE BOARD.

REPORT OF THE BOARD OF TRUSTEES.

To His Excellency, the Governor:

I herewith submit to you the report of the President of Purdue University for the year ending June 30, 1889, and the financial report for said year and for the three months ending October 31, 1889.

Very respectfully,

CHAS. B. STUART,

President of the Board of Trustees.

PURDUE UNIVERSITY, LAFAYETTE, IND., Feb. 1, 1890.

THE PRESIDENT'S REPORT.

To the Board of Trustees of Purdue University:

The law of the State requires the Trustees of Purdue University to submit a biennial report concerning the operation of Purdue University, and that report is due during the fall next preceding the biennial sessions of the Legislature.

The act of Congress under which Purdue University was established requires an annual report. This report is made, therefore, in obedience to the act of Congress. It is brief, although sufficiently extended to meet the requirements of the law. The same subjects will be treated more extensively in the biennial report, which will be made next December.

ATTENDANCE.

The whole number of students in attendance during the year ending June 30, 1889, was 439, classified as follows:

COLLEGE.		
Post-Graduates	34	
Seniors	29	
Juniors	32	
Sophomores	52	
Freshmen	92	
Irregular and Special	31	
School of Pharmacy	28	
Winter School of Agriculture	15	
School of Domestic Economy	15	
		328
PREPARATORY CLASS.		
Regular	76	
Irregular	35	
		111
Grand total	...	439

The following table will show the growth of the Institution in respect to attendance since its organization, the respective figures being for the year ending June 30, of the years named:

	College.	Preparatory.	Both.
1875	15	49	64
1876	17	49	66
1877	60	79	139
1878	65	101	166
1879	76	119	195
1880	86	117	203
1881	113	141	254
1882	111	127	238
1883	106	113	219
1884	112	101	213
1885	127	132	259
1886	159	156	315
1887	230	162	392
1888	269	99	368
1889	328	111	439

The following table gives the number of students in the departments each year since its opening in 1874:

College and Special Schools.	1875	1876	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889
Post graduates	..	..	1	3	1	2	2	3	3	4	2	3	11	28	34
Seniors	1	1	2	4	2	7	8	11	15	12	12	16	8	26	29
Juniors	..	1	6	5	14	11	13	20	13	14	16	10	34	31	32
Sophomores	3	6	6	12	15	22	30	18	20	20	16	27	49	42	52
Freshmen	9	8	23	28	34	36	39	47	37	42	67	76	91	78	92
Elective and special	2	1	22	13	10	8	21	12	18	20	7	14	18	24	46
School of Pharmacy	..	..	..	..	..	..	..	..	..	..	7	13	19	28	28
Winter Sch'l of Agriculture	..	..	..	..	..	..	..	..	..	..	..	.	..	14	15
Total	15	17	60	65	76	86	113	111	106	112	127	159	230	269	328

Preparatory Department.	1875	1876	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889
Senior preparatory	23	13	28	29	35	46	57	48	35	59	96	116	117	74	76
Junior preparatory	26	22	33	45	48	71	58	38	31	†	.	..	..	..	..
Irregular	..	14	18	27	36	.	26	41	44	42	36	40	45	25	35
Total	49	49	79	101	119	117	141	127	113	101	132	156	162	99	111

Year.	*No. of Counties.*
1882–3	37
1883–4	46
1884–5	54
1885–6	56
1886–7	62
1887–8	68
1888–9	70

The counties represented during the past year are as follows:

Allen,	Grant,	Madison,	Rush,
Bartholomew,	Greene,	Marion,	St. Joseph,
Benton,	Hancock,	Marshall,	Shelby,
Boone,	Hendricks,	Miami,	Steuben,
Carroll,	Henry,	Montgomery,	Sullivan,
Cass,	Howard,	Morgan,	Switzerland,
Clark,	Huntington,	Newton,	Tippecanoe,
Clinton,	Jackson,	Noble,	Tipton,
Dearborn,	Jasper,	Ohio,	Vermillion,
DeKalb,	Jay,	Owen,	Wabash,
Delaware,	Jefferson,	Parke,	Warren,
Elkhart,	Jennings,	Perry,	Warrick,
Fayette,	Johnson,	Pike,	Washington,
Floyd,	Knox,	Posey,	Wayne,
Fountain,	Kosciusko,	Pulaski,	Wells,
Franklin,	Lake,	Putnam,	White,
Fulton,	Laporte,	Ripley,	Whitley,
Gibson,	Lawrence.		Total, 70.

STATES REPRESENTED.

The States represented in the Institution during the present year are as follows:

Alabama,	Kansas,	Massachusetts,	New York,
Dakota,	Kentucky,	Michigan,	Ohio,
Illinois,	Maine,	Minnesota,	West Virginia,
Indiana,	Maryland,	New Mexico,	Wisconsin,
Iowa.			Total, 17.

FOREIGN COUNTRIES.

Japan, Spain.

CONCERNING THE ATTENDANCE IN THE SCHOOL OF AGRICULTURE.

It is a matter of regret that so few students enter the School of Agriculture. While the number has steadily increased during the past five

or six years, there having been during the year for which this report is made four times as many in this department as there were in 1883, yet it is not as large as it should be.

It is fair to ask " Why is this so?" Every effort has been made on the part of the Trustees and Faculty to render the course in this school an attractive one, as the following facts will show:

Previous to the year beginning September 1, 1884, all the work in the School of Agriculture was done by one professor. He taught agriculture, horticulture, stock-raising, veterinary science, forestry, drainage, landscape gardening, etc., etc. He was thus compelled to teach a greater variety of subjects than any other instructor in the Institution. He found it impossible to cover so much ground and do the best kind of work. It was, therefore, thought advisable to endeavor to make the work in this school more efficient by employing additional instructors. Accordingly, in 1884, an instructor in horticulture was employed, and in 1888 an instructor in veterinary science was added to the staff At the present time we have a larger force of professors doing technical work in the School of Agriculture than there is in any other school in the University; and more money is spent per capita for the technical instruction in this school than in any other. The course adopted in 1883 was an extensive one, but the present course provides for two hundred and twenty hours more of technical instruction than the course of 1883 did.

In addition to this, an especial effort has been made during the last three years to advertise the School of Agriculture among the farmers, and special inducements have been offered for the purpose of persuading young men to enter this department of the University. Among the means used to this end is the scheme adopted two years ago by the Board, permitting each grange of the State to fill two scholarships on exceptionally favorable terms. It was provided that these scholarships should be filled by sons or daughters of farmers, with the hope that the young men who were appointed would enter the School of Agriculture.

Two years ago the Board adopted another plan by which it was thought that the School of Agriculture would be made popular. A special School of Veterinary Science was organized, the course providing for one hundred and twenty lectures upon veterinary and agricultural subjects. This work was cheerfully undertaken by the Faculty, was in addition to their regular work, and was done without extra compensation. The school was fairly successful, but it was found that most of the students in it came from outside the State. It has been thought best, therefore, to modify the course and base it more upon agriculture and horticulture than upon veterinary science, and to limit its benefits to Indiana students. It is too early to tell what the effect of this change will be. It is hoped that it will be beneficial.

Although comparisons do not always furnish the best basis for argument, yet it is fair to say that in comparison with many of the largest land-grant colleges in the United States, in respect to the extent and variety of the course of instruction in agriculture and kindred subjects, and in respect to the comparative number of students in attendance, the showing for Purdue is a favorable one. Any complaint, therefore, that the lack of students in the School of Agriculture is due to apathy or neglect on the part of the management is without foundation. The Faculty believes that it would be the best thing possible for the State if we could have two or three hundred young men come to Purdue from the farms, who would, after being educated, return to the farms. No pains have been spared by them, as shown above, to secure this result. The truth is that the farmers themselves are not yet alive to the necessity for giving their sons, who expect to remain on the farm, a liberal education. I believe that public sentiment is rapidly changing on this subject, however, and that it will soon be seen that there is as much necessity for educating farmers as for educating lawyers, doctors and ministers.

IMPROVEMENTS.

At the last session of the Legislature thirty thousand dollars ($30,000) was appropriated for the purpose of making extensive improvements to the University. These improvements were commenced in April, 1889, but they are not yet completed. A full report concerning them will be made in my next biennial report.

Respectfully submitted, J. H. SMART,
President.

Receipts of Treasurer Purdue University from June 30, 1888, to June 30, 1889.

July 3	Cash of State Treasurer, interest on bonds	$8,500 00
September 21	Cash of University Registrar	2,230 00
October 2	Cash of State Treasurer, interest on bonds	8,500 00
December 15	Cash of University Registrar	427 40
1889.		
January 26	Cash of University Registrar	1,615 50
April 6	Cash of University Registrar	213 83
April 16	Cash of University Registrar	1,232 00
May 18	Cash of State Treasurer on appropriation	24,000 00
May 24	Cash of State Treasurer on appropriation	15,750 00
June 8	Cash of State Treasurer, Special Improvement Fund, mech.	2,000 00
June 8	Cash of State Treasurer, Special Improvement Fund, elec	2,000 00
June 8	Cash of State Treasurer, Special Improvement Fund, Station and Farm	3,000 00
June 29	Cash of University Registrar	986 22

JAMES M. FOWLER,
Treasurer Purdue University.

Receipts of Treasurer Purdue University from June 30, 1889, to October 31, 1889.

1889.		
August 13. . .	Cash of State Treasurer, special improvement, mech	$5,000 00
August 13. . .	Cash of State Treasurer, special improvement, elec	3,000 00
August 13. . .	Cash of State Treasurer, special improvement, Station and Farm	6,000 00
September 26 .	Cash of State Treasurer, appropriation.	10,000 00
September 30 .	Cash of State Treasurer, special improvement, mech	3,000 00
September 30 .	Cash of State Treasurer. special improvement, elec	7.000 00
October 3 . . .	Cash of Secretary, students	2,800 00
October 19. . .	Cash of State Treasurer, appropriation.	1,250 00
October 21. . .	Cash of State Treasurer, special improvement, mech	5,000 00
October 21. . .	Cash of State Treasurer, special improvement, elec	3,000 00
	Total	$46,050 00

JAMES M. FOWLER,
Treasurer Purdue University.

Expenditures in General Fund Purdue University, Year Ending June 30, 1889.

Trustees' mileage and per diem	$206 45
Salary treasurer and secretary	849 99
Commencement expenses	300 23
Supplies	5,110 24
Improvements	857 16
Printing and stationery	632 71
Care of buildings.	1,350 09
Advertising	1,363 29
Postage	243 25
Express, freight and hauling	2,097 04
Telephone	50 98
Telegraph	59 54
Apparatus and fixtures	2,261 92
Insurance	994 00
Repairs	679 72
Labor	982 86
Salary of faculty and instructors	24,776 66
Employes	2,626 39
Books and periodicals	622 87
Lectures	101 70
Traveling	153 03
Clerical work	1,168 04
Room rent and rebate fees	525 42
Rental of pianos	134 00
Catalogues	884 42
Farmers' Institutes	168 27
Miscellaneous	243 74
Total	$49,444 01

The above is a correct statement of the expenditures of Purdue University from June 30, 1888, to June 30, 1889, as taken from my books.

E. A. ELLSWORTH,
Secretary of Board of Trustees.

EXPENDITURES.

General Fund Purdue University, June 30 to October 31, 1889.

Trustees' mileage and per diem	$267 45
Salary of treasurer and secretary	458 32
Commencement expense	24 35
Catalogues	34 50
Farmers' Institute	7 40
Improvements	1,476 40
Printing and stationery	174 91
Care of buildings	510 26
Advertising	136 41
Postage	34 50
Express and freight hauling	258 52
Telephone	30 00
Telegraph	21 74
Apparatus and fixtures	3,381 17
Insurance	36 00
Repairs	870 38
Interest on Purdue warrants negotiated	145 59
Miscellaneous	4 90
Labor	287 55
Salary of faculty and instructors	6,294 67
Employes	686 86
Books and periodicals	103 49
Lectures	7 30
Clerical	208 35
Traveling	142 61
Supplies	2,903 18
Total	$18,506 81

The above is a correct statement of the expenditures of Purdue University from June 30 to October 31, 1889.

E. A. ELLSWORTH,
Secretary of Board of Trustees.

Special Improvement Fund—Electrical Laboratory—Year Ending June 30, 1889.

EXPENDITURES.

Architect's fees	$300 00
Excavating inside foundation walls	6 00
Total	$306 00

The above is a correct statement of the expenditures of the Special Improvement Fund, Electrical Laboratory, for the time above mentioned, as taken from my books.

E. A. ELLSWORTH,
Secretary of Board of Trustees.

Special Improvement Fund—Electrical Laboratory—June 30, to October 31, 1889.

EXPENDITURES.

Builder's estimates	$12,850 00
Freight express and hauling	7 11
Apparatus and fixtures	530 00
Total	$13,387 11

The above is a correct statement of the expenditures of the Special Improvement Fund, Electrical Laboratory, for the time above mentioned, as taken from my books.

E. A. ELLSWORTH,
Secretary of Board of Trustees.

Special Improvement Fund—Mechanical Laboratory—Year Ending June 30, 1889.

EXPENDITURES.

Builder's estimate No. 1	$1,000 00
Advertising	52 60
Apparatus and fixtures	8 22
Supplies	10 21
Total	$1,071 03

The above is a correct statement of the expenditures of the Special Improvement Fund, Mechanical Laboratory, for the time above mentioned, as taken from my books.

E. A. ELLSWORTH,
Secretary of Board of Trustees.

Special Improvement Fund—Mechanical Laboratory—June 30, to October 31, 1889.

EXPENDITURES.

Builder's estimates	$2,600 00
Freight express and drayage	123 50
Apparatus and fixtures	3,834 39
Labor	414 50
Miscellaneous	27 01
Supplies	380 33
Total	$7,379 73

The above is a correct statement of the expenditures of the Special Improvement Fund, Mechanical Laboratory, for the time above mentioned, as taken from my books.

E. A. ELLSWORTH,
Secretary of Board of Trustees.

Special Improvement Fund—United States Experiment Station and Experiment Farm—Year Ending June 30, 1889.

EXPENDITURES.

Builders' estimates Nos. 1, 2, 3—annex to station	$1,750 00
Balance on heating apparatus	554 00
Total	$2,304 00

The above is a correct statement of expenditures in the United States Experiment Station and Experiment Farm Fund, as taken from my books.

E. A. ELLSWORTH,
Secretary of Board of Trustees.

Special Improvement Fund—United States Experiment Station and Experiment Farm—June 30 to October 31, 1889.

EXPENDITURES.

Estimates of builder	$4,050 00
Architect fees	150 00

Steam heating annex	$210 00
Insurance on feed barn	50 00
Fences, grading roads and walks	325 96
Supplies	36 00
Miscellaneous	15 75
Total	$4,837 71

The above is a correct statement of the expenditures of the Special Improvement Fund of the United States Experiment Station and Experiment Farm for the above mentioned time, as taken from my books.

E. A. Ellsworth,
Secretary of Board of Trustees.

SECOND ANNUAL REPORT

—OF THE—

Agricultural Experiment Station,

OF INDIANA,

FOR THE YEAR 1889.

BOARD OF CONTROL.

William A. Banks	Laporte.
Charles B. Stuart	Lafayette.
Adison Bybee	Indianapolis.
Wm. H. Ragan	Greencastle.
Edward P. Hammond	Rensselaer.
Jasper N. Davidson	Whitesville.

OFFICERS OF THE BOARD.

Charles B. Stuart	President.
Edward A. Ellsworth	Secretary.
James M. Fowler	Treasurer.

James H. Smart, LL. D	President of the University.

STATION STAFF.

Horace E. Stockbridge, Ph. D	Director.
William C. Latta, M. S	Agriculturist.
James Troop, M. S	Horticulturist.
Henry A. Huston, A. M., A. C	Chemist.
Joseph C. Arthur, D. Sc	Botanist.
Francis M. Webster	U. S. Dep. of Agriculture, Entomologist.
Theries D. Hinebauch, M. S., V. S	Veterinarian.
Arthur Goss, B. S., A. C	Assistant Chemist.
Henry L. Bolley, M. S	Assistant Botanist.
W. O. Fritz, M. S	Farm Foreman.

To the Governor of Indiana:

I herewith present the Annual Report of the Agricultural Experiment Station of Indiana, due on or before the 1st of February, 1889, the same being required by section 3 of an act entitled "An act to establish Agricultural Experiment Stations in connection with the colleges established in the several States, under the provisions of an act approved July second, eighteen hundred and sixty-two, and of the acts supplementary thereto."

This report consists of a report of the Director of the Station, and the financial report of the Secretary of the Board of Trustees.

Respectfully submitted.

J. H. SMART,

President.

PURDUE UNIVERSITY, LAFAYETTE, IND., Feb. 1, 1890.

REPORT OF THE DIRECTOR.

To the Board of Control:

In compliance with the act of Congress calling this Station into existence, I submit my annual report of the work of the Indiana Agricultural Experiment Station for the year 1889. The year just completed is the first entire year during which the Station has been working fully organized under the provisions of the so-called Hatch act of Congress. During this year the permanent organization of the Station was effected, and a scheme of work adopted and put into execution from which valuable results are hoped in the future, but toward which end it can not be claimed that more than a beginning has already been accomplished.

In effecting the organization of the Station, and adopting a permanent scheme of work and investigation, the object held steadfastly in view has been fundamentally the rendering of definite practical assistance to the farmers of the State, and that the advancement of science or the promulgation of new theories were wholly secondary and incidental. The advancement of agriculture by the application to its processes of scientific methods and principles whereby a more economical and successful agriculture shall result, is the goal toward which our efforts are directed.

The Station Staff has, in its personnel, undergone considerable modification since the last annual report was issued. The present Director assumed the duties of his position February 1. On March 25, Lieut. Carl A. Wulff, M. S., who had acted as Vice Director until that time, was obliged to return to his home in Sweden, and the position thus left vacant has not been filled. July 1 the strength of the staff was increased by the addition of Mr. Arthur Goss, B. S., A. C., as Assistant Chemist, and Mr. Henry L. Bolley, M. S., as Assistant Botanist. On September 1 the work of the Station was concentrated, economized, and I believe increased in efficiency, by abolishing the position of Florist, the duties of which position naturally devolved upon the Botanist and Horticulturist of the Station. No other changes have been effected in the staff, and the work has steadily progressed without friction and with such unanimity of purpose as have necessarily resulted in commendable and satisfactory labors.

Equipment.—Changes in the equipment of the Station effected during the year have been chiefly the result of the munificence of our last State Legislature, which appropriated $15,000 for new buildings, improvements on Station grounds and additions to the Laboratory and farm equipment.

Two new buildings have already been completed. A large addition to the main Station building, increasing the office facilities of the Station and furnishing us with a large Laboratory room intended for the Agricultural Department, and which will ultimately be equipped with particular reference to a thorough investigation of the origin, characteristics, needs, adaptations and possibilities of the typical soils of Indiana. The other building, already built and in use is the Experimental Feeding Barn, constructed with special reference to an investigation of feeding and dairy products, and in accordance with the best plans which practice and theory could suggest for the accomplishment of the end in view. The structure is sixty feet long by forty wide, with two projections, one for office and weighing purposes, the other containing the engine room, silos, granary and cutting and grinding machinery.

This barn was not constructed as a model barn, to be reproduced on the private farms of Indiana. It was planned with particular reference to the work to be conducted. We claim for it that it is well adapted to our conditions, although doubtless, as a whole, little suited to average farm purposes. Two quite different conditions or purposes were, however, recognized in its construction. First, it must satisfy the requisites of careful experimental work, a laboratory for investigation. Second, it must answer the purposes of a general farm barn because of the fact that our entire farm is much too large to be devoted entirely to experimental purposes with the income at our command.

Recognizing these two somewhat conflicting purposes, we endeavored to harmonize them in one structure by dividing the building through the center by a solid partition and placing the experimental work in one end and the routine farm work in the other end, with perfect communication between the two. The east or farm end has a single feeding floor, facing which are two rows of stalls, each capable of furnishing eight animals with convenient quarters. Each stall is equipped with a Newton automatic tie, giving perfect ease and freedom of motion, with the advantage of keeping the animal clean by drawing her forward when she lies down and pushing her backward when she stands. The stalls are provided with a continuous gutter, one foot in width, the utility of which is doubled by laying the rear end of the stall with oak slats one and one half inches wide with one inch spaces between. The stalls are four feet in width with a one inch slope from manger to gutter. The west, or experimental, end of the barn possesses also a single feeding floor, facing which, from one side, are eight stalls identical with those in the other end of the barn, except that the manger is modified to facilitate more perfect cleaning. The other side of this feeding floor, which is ten feet in width, is occupied by three large box stalls for special work, and by the platform scales, furnished by the Howe Scales Company, ballasted to two thousand pounds, graduated and sensitive to two-tenths of a pound, for weighing animals and fodder. From

this feeding floor opens a passage way, on one side of which are the two silos and on the opposite side the grain and engine rooms. From the other end of this floor opens the office and record room, communicating with which is a room designed for the weighing of milk and the storage of apparatus and utensils.

The upper story of the barn is communicated with by two flights of stairs, one from the engine room and one from the feeding floor. The entire upper floor of the main barn is occupied by a storage loft for hay and fodder, with a capacity of seventy-five tons. Into each end of this loft open doors through which hay is conducted directly from the wagon, standing outside, by the use of a trolly hay-fork, thus effecting very great economy in room, and we find, by one season's use, materially decreasing the labor and time required for housing our fodder crops.

The capacity of the barn is twenty-four head of cattle, exclusive of the box stalls, and at this writing sixteen milch cows and eight steers are being subjected to careful feeding experiments by means of the facilities here furnished.

A thorough and detailed description of the two silos constructed in this barn will find proper place in the bulletin soon to be published, giving the results of our feeding experiments with ensilage. In passing, however, I will simply say that the silos are constructed in the barn, opposite the engine room, thus convenient to power and cutting machinery. They are two in number, each fifteen feet square and twenty feet deep, extending from barn foundation to eaves; constructed entirely of wood, with tarred paper between the board linings, with cemented bottoms, perforated in the center with glazed tile, extending to the porous gravel sub-soil, covered, however, when the silos are filled, but opened for drainage and cleaning purposes when the ensilage becomes exhausted.

One silo is at present filled with clover, the other with corn, the results of feeding, which will be made public in an early bulletin.

Additional improvements in equipment will be effected at an early day, having been provided for by the legislative appropriation alluded to. Indeed a partial equipment in dairy appliances has already been procured and is in use. A building for the exclusive use of the dairy department, however, will be erected during the coming season, besides which greenhouse and additional veterinary facilities have been decided on and will be effected at an early day.

Investigations Undertaken.—At the beginning of the present year a permanent scheme of work was adopted and actually instituted, embracing the following investigations: 1, Investigation of the typical soils of the State, their geological origin, present physical condition and chemical composition, with actual field trials on different geological formations. 2, The use of the lysimeter in the study of the relation between the soil, its water, heat and elements of fertility. 3, A study of soil absorption and

the fixing power of the soils for plant food. 4, The relations between rotation and succession of crops, the relations between continuous grain-growing and grain interspersed with grasses or forage crops. 5, A study of bogus "soils." 6, Wheat experiments, varieties, dates, rates and methods of seeding and size of seed. 7, A repetition of this work with corn and oats, together with methods of cultivation of the former crop. 8, Soil tests with fertilizers. 9, The relation between storing hay in barns and stacks as affecting composition and nutritive value. 10, A study of different methods of curing and storing fodder crops, drying vs. siloing as affecting actual feeding value. 11, A study of cold vs. warm water consumed by milch cows during cold weather. 12, Divided milkings. 13, A study of milk secretion. 14, A study of the lactation period. 15, Testing varieties of fruits and vegetables. 16, Crossing grains and fruits and growing new seedlings. 17, Improving native wild fruits. 18, A study of the properties and feeding value of all grasses known to grow within the State. 19, A study of gooseberry mildew. 20, Wheat rust. 21, Smut of wheat and oats. 22, Potato scab. 23, The edible fungi; the occurrence and food value of the same. 24, Methods for increasing the earliness of maturity with potatoes. 25, A study of grain insects. 26, Observations on the rearing and characteristics of the plum curculio. 27, Investigation of the habits of little-understood insects, injurious or beneficial to the agricultural interests, including the propagation of parasites of certain depredatory insects. 28, Investigation of the causes, symptoms, treatment and ultimate results of distemper in horses and cattle.

Publications.—Much of the work undertaken in accordance with the above scheme has already been completed and the results made public in the form of bulletins published at intervals during the year. The entire number of publications thus given out has been twelve, as follows:

No. 18. January—Experiments with Vegetables. By the Horticulturist. Eleven pages.

No. 19. January—Spotting of Peaches and Cucumbers. By the Botanist. Ten pages.

No. 20. January—Cross Fertilization. Culture of Tropical Ferns. By the Florist. Eleven pages.

No. 21. February—Rational Feeding. By the Vice Director. Sixteen pages.

No. 22. March—Commercial Fertilizers. By the Chemist. Sixteen pages.

No. 23. April—Experiments with Corn. By the Agriculturist. Twelve pages.

No. 24. May—Cold vs. Warm Water. Divided Milkings. Milk Secretion. By the Vice Director. Sixteen pages.

No. 25. June—Entomological Experiments. By the Entomologist. Eighteen pages.

No. 26. July—Wheat Rust. By the Assistant Botanist. Nineteen pages.

No. 27. August—Field Experiments with Wheat. By the Agriculturist. Twelve pages.

No. 28. September—Smut of Wheat and Oats. By the Botanist· Twenty-three pages.

No. 29. December—Grasses of Indiana. By the Horticulturist. Forty-four pages.

These bulletins embrace one hundred and ninety-seven pages of matter, and most of them were illustrated as follows: No. 18, one diagram; No. 19, one diagram and six cuts; No. 20, six cuts; No. 21, one diagram and one levytype plate; No. 25, three cuts; No. 26, nine cuts; No. 28, seven cuts; No. 29, nineteen full page illustrations of grasses.

The character of the work, the results of which have been recorded in these bulletins is, I believe, illustrated by the fact of the esteem in which it is held by other Stations. One of our bulletins, viz., that upon Smut of Wheat and Oats, was reprinted entire for distribution by Stations in two other States, due credit being given us for the same; and further another bulletin, that on Fertilizers, required a second edition, which became nearly exhausted before the demand for its use among farmers was satisfied.

In August an endeavor was made to increase the direct usefulness of the Station through a more extended utilization of the press of the State for the dissemination of the published results of our work. The end in view and the methods adopted for its accomplishment are fully expressed in the following letter:

GOVERNMENT AGRICULTURAL EXPERIMENT STATION FOR INDIANA.

LAFAYETTE, IND., August 15, 1889.

Mr. Editor:

DEAR SIR—The law of Congress appropriating funds for the maintenance of Government Agricultural Experiment Stations, in the various States, provides that these Stations be endowed with the Franking privilege, that all their publications may be mailed free, first, to all farmers of the State requesting the same, and second, to every newspaper in the State.

These requirements are obligatory, and in compliance with them, the monthly bulletins of this Station regularly reach several thousands of farmers of the State and every newspaper specified by the law.

The demand for these publications has become very great, and is constantly increasing at a very rapid rate. The Station has but one object or end in view in its work, viz: the accomplishing of the greatest practical good to the farmers of the State of Indiana in whose interests it is en-

dowed. With this end in view it is our desire to bring the results of our labors as directly and immediately as possible to the knowledge of the greatest possible number of persons interested.

Our own publications of course do this as far as they go, but, doubtless, it was the intent of Congress in requiring stations to forward all publications to the newspapers of their respective States to call the aid of the press into requisition in disseminating the results of the work.

Several hundred newspapers in Indiana receive regularly the bulletins of this Station, and yet a very small proportion of these journals ever reprint any portion of the bulletins, or allude editorially to their contents.

This we do not believe is because of a light value placed on the contents of the bulletins, but rather to the fact that they usually contain several pages of material, by far too much to admit of reprinting in full, and editors are as a rule too busy to digest this material and cull those portions which might be most advantageously selected for publication.

We believe therefore that most journals would thankfully receive from us a brief, terse and plain synopsis of such actual results recorded in the bulletin as are deemed of most actual practical value, and would willingly consent to the regular publication of such a synopsis were it furnished them ready to hand.

We have decided at any rate to try the experiment, and hereafter bulletins forwarded to the press will be accompanied by a synopsis of their contents, ready for publication.

What we desire is not advertising, newspaper comment or anything of the "puff" character. We simply desire that the public, which supports us, and in whose interests we are laboring, shall be made acquainted with the *actual results of our labors.* Further comment or honest criticism from the press we shall certainly appreciate when voluntarily made, but this plan which we propose, we believe would be to the material interests of all parties concerned, Station, Public and Press.

Hoping that it will meet with your favorable reception, I remain

Most respectfully yours,

H. E. Stockbridge,

Director.

The newspapers of the State, both daily and weekly, responded quite generally to the proposition made them, and as a result a very large number of farmers not otherwise reached have been brought into direct contact with the work of the station.

As an illustration of the method by which this end has been accomplished, I append entire the abstract of Bulletin No. 27, furnished the press of the State, the same having been very generally reprinted, and thus made available to the readers of the papers availing themselves of the material furnished them.

FIELD EXPERIMENTS WITH WHEAT.

ABSTRACT FROM BULLETIN NO. 27, OF THE AGRICULTURAL EXPERIMENT STATION OF INDIANA, AUGUST, 1889.*

This Bulletin is sent out in compliance with a custom practiced at this Station for several years of publishing, at the time of harvesting our wheat crop, the results of our season's experience, that the facts developed might be in possession of the farmers of the State in season to be utilized before the time for seeding the next year's crop of winter wheat arrived.

The wheat was sown near the last of September in a thoroughly prepared, dark, compact soil ot moderate fertility. A gravelly subsoil gave perfect natural drainage. The seeding was done with the Hoosier hoe drill, set to sow six pecks per acre.

The average yield for all varieties tested, or the entire experimental field, was 33.94 bushels.

I.

YIELDS OF VARIETIES PER ACRE.

NAME.	BUSH.	NAME.	BUSH.
Velvet Chaff	35.8	Fultz	35.1
Golden Cross	36.0	Dietz Longberry	32.9
New Monarch	31.5	Original Red	29.6
Red Fultz	30.7	Fulcaster	33.4
Ontario Wonder	31.8	Sibley's Imperial	34.4
Michigan Amber	32.1	Raub's Black Prolific	38.4
Currell's Prolific	29.0	Wyandotte	34 3
Mealy	28.6	German Emperor	33.8
Improved Rice	30.2	Velvet Chaff (white smooth)	34.6
Hedge's Prolific	36.3	European	33.0
Velvet Chaff (brown smooth)	35.6	Velvet Chaff (white bearded)	33.7
Egyptian	42.1	Poole	33.4

It will be observed that Velvet Chaff and Michigan Amber—our standard bearded and smooth sorts respectively—show good, though not the highest yields. Their chief merit is their hardiness, which is superior to most other kinds that have been fully tried at this station. It should be borne in mind, however, that hardiness is a prime characteristic of any wheat for this severe climate. The good quality of these two varieties—especially the Velvet Chaff—makes them deservedly popular, and accounts for the fact that the Secretary of Agriculture has purchased this station's entire supply of the latter kind for general distribution. The Egyptian wheat heads the list in point of yield this year, as it has done in two previous years. Its long, weak straw unfits it, however, for very rich soils.

NOTE.—All Bulletins of this Station will be mailed free to citizens of the State requesting the same and sending address to H. E. STOCKBRIDGE, Director, Lafayette, Ind.

II.

QUANTITY OF SEED TO THE ACRE.

Experiments to ascertain the most desirable rate of seeding, have been conducted six years under the following conditions: Ground of average fertility, well prepared and naturally drained; good seed drilled in without fertilizers, in the last third of September.

Yields, per Acre (Bushels).

Quantity of Seed Sown, per Acre.	1885	1886	1887	1888	1889	Average of Five Yrs.
Two pecks	16.4	18.5	27.3	7.7	19.9	17.96
Three pecks	25.3	24.7	31.4	7.2	23.1	22.34
Four pecks	*29.1	*27.4	*33.8	*11.2	*25.7	25.44
Five pecks	32.2	32.3	35.1	14.6	24.6	27.76
Six pecks	33.4	32.1	36.5	16.3	26.9	29 04
Seven pecks	32.2	35.0	35.7	16.1	29.2	29.64
Eight pecks	34.8	36.3	36.2	16.0	31.4	30.94

*Average of four duplicate plats.

The evidence steadily accumulates in favor of thick seeding. For rates higher than six pecks, the increase in yield is slight, but enough to justify the extra amount of seed required. The regular rate at the Station for the field crop is six pecks; and in several instances a thicker stand would have given a greater yield.

III.

BROADCAST AND DRILL SEEDING.

The results of four trials of broadcast and drill seeding are tabulated below. The broadcast seeding was done in 1884 and 1885, with the Strowbridge seeder, and in 1887 and 1888 with the Albion (Mich.) combined harrow and seeder. The drill seeding was done with the Hoosier hoe drill, The rate of seeding in each case was four pecks per acre the first two years, and six pecks the last two.

Broadcast and Drill Seeding.

No.	Methods of Sowing.	1885	1886	1888	1889	Average of Four Yrs.
		bu.	bu.	bu.	bu.	bu.
1	Drilled	17.0	27.8	16.7	35.0	24.12
2	Broadcast	17.3	17.1	3.5	28.7	16.65
3	Drilled	20.9	25.7	17.8	31.8	24.05
	Average, Nos. 1 and 3	19.0	26.8	17.3	33.4	24.12
	Gain from use of drill	1.7	9.7	13.8	4.7	7.47

The broadcast plats have invariably been damaged most in winter. Much of the seed is left too near the surface in minute elevations of soil which the rains wash down, leaving the upper portions of the wheat roots exposed.

IV.

LARGE VS. SMALL SEED.

An experiment to determine the relative yields from large and small seed was undertaken. The two were separated by a seed screen and sown at the rate of six pecks per acre.

	Bushels.
1. Large seed	25.78
2. Small seed	25.76
Gain from large seed	0.02

The experiment will be repeated, and the small wheat for the next test will be selected from the small seed product of this year.

V.

CONTINUOUS GRAIN GROWING VS. ROTATION CROPPING.

Two series of experiments were begun in 1880 to determine the effect of grass on the yields of grain crops in a rotation involving both. Wheat, oats and corn were rotated in each series. The presence of grass and clover in one rotation, and their absence from the other constituted the essential difference between the two series. The average yields per acre of all the wheat plats in each series for the last three years are as follows:

	Bushels.
First series, grain crops only	10.7
Second series, grain and grass crops	15.5
Gain from rotation with grass	4.8

The yields of corn and oats also show the superiority of rotation of crops over constant grain growing. The yields are not large—they could not be; as manure, the *mainspring of successful agriculture*, is left out of both series. The purpose of the experiment was not to show the posibilities of crop production, but to emphasize the importance of growing grass and clover in connection with other crops.

SUGGESTIONS TO WHEAT GROWERS.

The following practical suggestions, based on the results of our experience at the Station, are offered in the confident hope that their application would result advantageously on a very large proportion of the wheat farms of Indiana:

1. Sow less wheat; grow more grass, and better live stock.

2. Select a hardy, prolific wheat, adapted to your soil and *stick to it.* Give it good treatment and it will *not* "run out." Sow not less than six pecks of sound seed to the acre.

3. Plow wheat ground early, and harrow *immediately* after plowing. You can thus more easily and more thoroughly pulverize the soil.

4. If ground breaks up cloddy, use heavy roll, alternating with some form of harrow or cultivator that will bring clods to surface.

5. If manure or fertilizers are used, mix thoroughly with soil in every case. Use only *rotted* manure, if any, and apply after plowing. Reserve the *fresh* manure for the corn crop.

6. Adopt a rotation of crops suited to your soil and needs. It will (1) increase the yield and improve the quality of your crops; (2) enable you to take better care of your live stock; (3) prevent serious insect depredations and fungous diseases; (4) improve your soil and make it more lasting, and (5) put money in your pocket.

Published Results of Work.—To state in detail the entire results of experimental work already made public would require a republishing to a large measure of the bulletins issued during the year, a useless procedure. It is, however, thought desirable to redirect attention to a few of the more definite practical results accomplished and already made public.

Bulletin No. 18. Tests of several varieties of sugar beet showed that roots with a sugar content as high as 16.4 per cent. could be grown in the latitude of Lafayette, an important fact, worthy of special consideration in light of published statement of the United States Department of Agriculture, that successful sugar beet culture was not possible south of Isotherm of 70° F. mean summer temperature. Temperature observations made at the Station, however, show the average mean for this locality to be 72.5° F.

The practical bearing of these facts lies in the utter failure of successful sugar manufacture from sorgum outside a very limited area in the State of Kansas, and the final recognition of the Department of Agriculture that its efforts must hereafter be directed toward the beet rather than the sorgum as a sugar producing plant, and that for this important industry northern and central Indiana are shown to possess special adaptations.

Bulletin No. 19. The peach crop of Indiana has become affected by a fungus disease heretofore only known to exist in southern Austria.

Bulletin No. 20. Several new varieties of Carnations were produced and the fact established that crossing of varieties was absolutely essential for the production of varieties distinct in color, and that for success in crossing, sunshine, relatively high temperature and a dry atmosphere gave best results.

Bulletin No. 23. First—Methods for conserving soil moisture must be practiced if maximum results with cultivated crops are to be obtained during dry seasons, the most effective means being the repeated thorough

pulverization of the surface soil to a depth not exceeding two inches, whereby the capillary tubes through which evaporation of soil moisture into the atmosphere is effected, resulting in a mulch of pulverized dry soil through which moisture can not pass into the atmosphere and become lost to the crop.

Bulletin No. 21. Placed the actual chemical composition of all common feeding stuffs in possession of the farmer and gave the methods by which rational and consequently the most economical food rations could be prepared from any food at hand and for any class of farm live stock, and showed the relations between the nutritive value of food fed and the manurial value of the refuse from this feeding, and consequently the most economical utilization of crops for feeding and manurial purposes.

Bulletin No. 22. By placing at the disposal of the Indiana farmers the analyses of all commercial fertilizers offered for sale within the State, and the principles involved in their application to the soils for the production of crops, together with the estimated commercial value per ton for each fertilizer enumerated, rendered their most economical utilization possible and reduced the probabilities of fraud in their purpose.

Bulletin No. 24. First—Warming water for milch cows during cold winter weather does not pay, provided the water is so stored that it is not allowed to freeze and that the animal is properly sheltered and fed. Second—By dividing the milkings of cows into two parts, the first part drawn and the second part drawn, the latter is found to possess a relative butter-making value of 43.55 per cent. greater than the former, and that by this method, by assorting the fat globules, those in each half being most nearly alike, the butter produced from either half is superior to that produced from the entire undivided milk.

Bulletin No. 25. First—The ravages of the plum curculio are only preventable by three means; by securing and destroying the beetles through jarring the trees and catching the falling insects on a cloth laid beneath; by allowing poultry or swine to feed upon the falling fruit, thus destroying the larvæ before their escape into the ground; by spraying the trees after the fruit has set with arsenical mixtures, for which purpose one-half pound of London purple, or one pound of Paris green, per one hundred gallons of soapy water. Second—No varieties of either native or imported plums are curculio proof. Third—The grain aphis has occasionally been numerous in America for some twenty years, never, however, with such wide-spread occurrence as during the past season, doubtless accounted for by the peculiarities of the weather previous to the 1st of June. They do not confine themselves to wheat but depredate upon all small grains, both in spring and fall. They are preyed upon by lady beetles and several minute hymenopterous parisites, to the activity of which we doubtless owe the comparative immunity from damage

during the past season, notwithstanding the overwhelming numbers at one time infesting our wheat fields, and from the exertions of which similar immunity in the future may be confidently expected.

Bulletin No. 26. First—Rusting of wheat results from the attacks of several different species of fungi. The disease is propagated by means of spores, one intermediate form of which is developed chiefly upon weeds, the destruction of which decreases the danger from serious attacks of rust on grain by destroying the plant on which the intermediate form of the disease subsists. One species at least (*P. rubigo vera*) succeeds in passing the winter in the tissues of the young wheat plant. Fourth—During warm weather any conditions of soil or atmosphere tending to retain the wheat fields in a moist condition conduce a rapid spread of the disease. Fifth—Low lying, moist, rich soils produce wheat most subject to the disease. Sixth—No known variety of wheat is rust proof, though some possess greater power of resistance than others. Seventh—An excess of nitrogen in the soil is regarded as conducive for the production of rusted wheat. So far as immunity from rust, therefore, is concerned, fertilizers containing only mineral matter are most advantageous. Eighth—Early ripening varieties enjoy greatest immunity from attacks of rust.

Bulletin No. 27. First—The disproportion between area of wheat and of grass is too great in the State. The proportion of the latter could be most advantageously increased. Second—Not less than six pecks per acre of seed wheat should be sown. Third—Wheat ground should be plowed early and harrowed immediately thereafter. Fourth—On cloddy ground the use of a heavy roll, alternated with some form of harrow, will be found most advantageous. Fifth—The introduction of grass as a crop in a grain rotation may increase the average yield of wheat per acre from four to five bushels without the use of fertilizers in any form.

Bulletin No. 28. First—Bunt, or stinking smut, is one of the most destructive of all grain diseases, not injuring a part of the grain but absolutely ruining the heads affected, the amount of damage being proved by actual count to be more than 50 per cent. of the entire crop. Second—The disease is the result of the growth of a fungus living within the tissues of plants, there being two species; *Tilletia tritici*, with rough spores, and *Tilletia foetens*, with smooth spores. Third—The disease is propagated by spores, a single one of which may cause all the heads of a stool of wheat to become diseased. Fourth—The disease does not spread from plant to plant or from field to field, the infection always occurring at the time the seed sprouts. Fifth—No remedy can be applied to the growing crop, but smutty seed can be purified and the occurrence of the disease is absolutely prevented, unless the seed be sown on ground containing smut spores from a previous crop, by being thoroughly wet by a solution of blue vitriol, one pound or more per gallon of water. Sixth—

Thresher, storing bin, grain sacks and all other appliances coming in contact with the seed wheat can and should be disinfected by the same means. Seventh—The vitality of the propogating spores in the soil does not exceed two years, so that allowing a field once having produced smutted grain an interval of two years before reseeding prevents a reoccurrence of the disease. Eighth—Common, or black smut, is caused by a distinct fungus, *Ustilago segetum*, attacking not only wheat but all other small grain. The methods of prevention or protection are identical with both forms, except that weaker solution, four ounces to the gallon and a longer emersion—not less than thirty-six hours—are advised for black smut.

Bulletin No. 29. First—This bulletin places at the disposal of the farmer a concise, plain description of every grass known to grow within the borders of the State to the number of one hundred and twenty-eight species, some thirty of which were previously unrecorded as found in Indiana. Second—The true importance of grass as an element in the agriculture of the State is enforced by a comparison of the area in grass and the area in tilled crops for Indiana and for the entire United States, the ratio for Indiana being one of grass to five and four-tenths for tilled crops, while for the entire country one of grass to three and seven-tenths of tilled crops. The importance of the comparison lies in the fact that in the different States the value of dairy stock and products is proportional to the ratio between area in grass and in tilled crops. The greater the area of the former to the latter the higher the average value of milch cows and dairy products.

In addition to the publications already recorded the Station has, beginning with May, during which month the State Weather Service was transferred to the control of the Station, published the regular monthly bulletins and the weekly crop reports issued during the growing season.

The weather bulletins were printed to the number of five hundred each month, and the crop reports published on narrow strips for distribution to observers and the press. This service having been transferred to the Station during the year, it was not deemed advisable to change the methods heretofore in vogue until the completion of the year. The work of the Station, however, is conducted, and must be conducted, fundamentally for the benefit of the farmers of the State, and the same must hold true of the Weather Service. It is doubtful, however, if either the weather bulletins or the crop reports have found their way to any considerable number of farmers. During the present year, therefore, it is hoped to effect such a change as will result in bringing whatever benefits may accrue from systematic weather and climatic observations into more direct contact with the farmers of the State, reducing the work simply to its agricultural aspects.

Condition of Uncompleted Work.—The character of much of the work embraced in the scheme of investigation being followed by the Station is

necessarily such as to inevitably require years before definite results can finally be hoped for. Many subjects at present receiving attention from the Station staff are consequently in such a condition that no results have been obtained and no facts yet published. Even where bulletins have been published the results recorded are really simply reports of progress. Certain other work of the Station, however, is in such a condition that a statement of the actual present status of the work may not be without value.

Our study of the origin, composition, characteristics and adaptations of the soils of the State has resulted in the accumulation of many data and the completion of a large number of analyses of soils from many different parts of the State. We have, moreover, during the past year had actual field trials with crops in progress in five different localities, on as many different soils, directed toward a study of soil characteristics and requirements through the actual medium of the crop in conjunction with the analyses made, and in one locality at least the results promised to be of considerable definite value to the farmers of the region.

The use of the lysimeter, in studying the relations between the soil and its water, heat and elements of fertility, has been simply preliminary work as preparatory to future investigations, inasmuch as it was considered absolutely essential that one full year intervene between the artificial filling of the lysimeters and their application to the study of soil conditions relating to the soils of the field. The records and analyses, however, have been carefully made, and we believe next season's work will develop facts of no little value. One occurrence of a phenomenon associated with the lysimeter, of exceptional character and interest, was noticed about the first of June. One lysimeter in each set, or of each depth, was filled entirely with surface soil, the filling having been completed in December, 1888. As was to be expected, the porous soil sifted into these lysimeters, gradually solidified during the winter, and with the opening of spring they were again filled to within three inches of the surface with soil reserved for the purpose. No material compacting of the soil occurred during the dry spring of 1889, until the heavy rains occurring during the last week of May and the first few days of June. With the advent of these rains, however, the soil in these two lysimeters began gradually to sink by compacting, until the surface soil in the six-foot lysimeter was more than a foot below the upper edge of the lysimeter. During this entire period of heavy rains, aggregating 6.10 inches between the dates of May 18th and June 6th. The percolation from the corresponding six-foot lysimeter filled with natural soil in place, aggregated twenty-four and sixty-five one hundredths litres; yet not a drop of water had found its way through the lysimeter filled with surface soil. So unexpected was this difference in percolating activity, that fears were entertained that a leak must exist in the lysimeter, though no traces of any such condition were discernable. Believing the results of

the rain and the impacting of the lysimeter soil to be at an end, the lysimeter was again filled with surface soil to within three inches of its upper edge. Eleven inches of dry, porous, surface soil was thus added. Almost immediately, within two hours after this mulch of eleven inches of dry soil was added to the surface, free percolation from this lysimeter began and continued for several days.

The inference from these occurrences seems to be clear; indeed the fact seems to be demonstrated beyond reasonable doubt that the addition of the dry soil to the surface served as a mulch through which capillary action could not exert itself, evaporation from the surface was absolutely checked and the upward movement of soil water, being prevented, downward capilarity exerted itself, and percolation from the bottom of the lysimeter immediately followed.

The practical deductions from this occurrence being the utility of disturbing the upper surface of field soil to prevent evaporation and conserve soil waters within the reach of the plant during times of drought.

One other phenomenon was noticed in connection with lysimeter percolation. The lysimeters are situated on the Station grounds about one mile from the Wabash River and 160 feet above the stream. During the season of 1889 there were three high floods of the river, resulting from protracted rain, and in each case it was observed that the maximum elevation of the river and the maximum percolation from the lysimeters—in other words, when the flood began to decrease and the waters to subside, percolation from the lysimeters began to diminish. This repeated reoccurrence was probably hardly more than a coincidence, yet as stream waters are chiefly percolated waters, finding their way to the streams through the soil, and as the lysimeter is an accurate measurer of the soil percolation, there seems to be a possible connection between the phenomena observed, a connection which, in case of a repetition of the occurrence, will be observed with much interest.

The field work with crop rotation, and with the methods of seeding, cultivating and utilizing farm crops, may never be said to be complete, and although results have been published concerning each of these problems, the work will be continued in the hope of further revelations.

Our experiments concerning the relative nutritive value of forage crops stored in barns and in stacks have been completed, so far as analysis go, but the feeding trials are at present in progress. The same fact is true of our comparisons of dried forage and ensilage, concerning which, however, a bulletin will be published at an early day.

In the Horticultural department a considerable number of promising new seedlings have been produced, together with the products of hydridization. The coöperative horticultural work, consisting chiefly in tests of new varieties in ten different localities of the State, continues as heretofore, one change in the personnel of parties having charge of such work

having been effected, Hon. Sylvester Johnson, of Irvington, having taken up the work dropped by the removal of Mr. A. G. Chandlee from the State.

In the Botanical Department the investigation of goosberry mildew resulted simply in showing the dependence of this disease upon atmospheric conditions, not a trace of the malady appeared on even our most susceptible varieties, though they were exposed to every condition thought conducive to the propogation of the disease.

The work undertaken with edible fungi is expected to result in facts of no inconsiderable economic value. Mushroons, puff balls and morels, being exceedingly nutritious and palatable, though the work in this line is still incomplete, facts new and of a practical value have already been deduced.

Incidentally during the year a new disease of a bacterial nature affecting Carnations was discovered, concerning which a brief statement has already been published; the work, however, is still in progress. A study of variations in plants grown from unripe seed has been in progress and a report has been made, though additional facts are sought by a continuation of the investigations. The same assertion is true of the influence of the weight of seed upon final product; tomatoes, sweet peas and balsams being the plants chiefly studied.

SPECIAL INVESTIGATIONS.

A considerable amount of work has been performed during the year outside of the pre-arranged scheme of investigation. Most of this has resulted from special inquiries made by farmers and has only individual importance. It has been our aim, however, to render the farmers of the State every possible assistance and reply to all queries, even to the extent of making special investigations where the case seemed to demand such, even though the subject was simply of individual or local significance. In the Chemical Department in particular a very considerable amount of work is done, consisting chiefly of analyses made for the benefit of individual farmers, or at the instigation of other departments of the Station. The results thus obtained seldom find their way into bulletins, yet not infrequently have a value making them worthy of permanent record, and the department is at least entitled to credit for the work thus done.

Among analyses to which these remarks refer may be included over one hundred analyses of milk, eleven analyses of cattle foods, ninety-two analyses of fertilizers, two toxicological investigations and analyses of soil samples from all the Station plots and a considerable number received from outside parties.

Certain individual analyses are worthy of record as possessing special significance. The gas liquor from the University gas plant was found to

contain 2.62 per cent. of ammonia, giving the liquor a considerably higher value than the tar, though the latter has heretofore been sold and the former allowed to go to waste.

A fertilizer offered for sale in the State was found to contain 39.12 per cent. less ammonia than the sample originally furnished for official analysis. A sample of steamed bone, the waste product from a glue factory and not heretofore utilized, was found to contain 30.78 per cent. of phosphoric acid and 2.05 per cent. of ammonia. Two bags of so-called fertilizers were forwarded to the Station for trial, being placed upon the market by the Bay City Fertilizer Co., one under the name of Phosphate Salt, the other as Fertilizing Salt. The claims made by the manufacturers were, first, exceptional fertilizing value, and second, the property of exterminating certain injurious insects, particularly wire worms and cut worms. A quantitative analysis of the so-called phosphate salt showed it to consist chiefly of crude sodium chloride (common salt) calcium sulphate and calcium carbonate, with a mere trace of phosphoric acid. The so-called fertilizing salt was found to possess the following composition:

Sodium chloride	97.70
Calcium sulphate	.44
Insoluble substance	.47
Moisture	1.09
Loss on ignition	.30

It therefore appears that neither of these substances contains any appreciable quantity of either nitrogen, potash or phosphoric acid, and therefore possess no rating as commercial fertilizers, although placed on the market at prices equal to those of reliable first-class articles. So far as the claim of insecticide value was concerned, careful and repeated trial by the Station Entomologist showed that they were effective in destroying insects only when sufficient of the salt was used to kill the plant and thus compel the insect to die of starvation.

Another material necessarily placed in a similar category was a so-called Preserver and Germinator of seeds, offered for sale by F. P. Dimpfel, of New York. It was claimed to be an "ammoniac substance", anti-parasitic and to possess manurial value. Analysis gave it the following composition:

Loss on ignition	9.90
Lead oxide (with acetic acid)	59.07

It is evidently a partly dehydrated acetate of lead, with an admixture of creosote, the latter possibly resulting from combustion of the organic impurities present. Field trials showed it to possess no activity for the purposes for which it was claimed to be a specific.

In the Veterinary Department a very large number of patients have been subjected to treatment frequently the methods employed being of

an experimental nature. The results in one such case are, I believe, of such a nature as to demand recording here. The disease in question consisting of fistulated withers, exceptionally prevalent in this vicinity. The first animal subjected to treatment had been twice operated upon by competent hands before being brought to our Veterinarian. The latter repeated the operation in the usual manner, laying the parts well open with a knife and using corrosive sublimate. The wound healed thoroughly, but the swelling still remained as on the two previous occasions. After a lapse of about three months the fistula again broke out and discharged, the animal being brought to the Station Veterinarian a second time He decided to operate again, using the firing iron in conjunction with the knife. A free incision was made, laying the sinus open to the bottom and carried out so as to allow free exit of the pus. The two pipes were then dissected away and the wound thoroughly cleaned with a 1-500 solution of corrosive sublimate.

The thermo cautery was then used, heated to a cherry red. With it the skin was punctured along the line of the rhomboideous longer muscle, passing the point well into the flesh. The firing was thus continued well up the neck, about thirteen incisions being made, and thence back as far as the space usually covered by the back pad of the harness. Both sides being affected, both were treated in like manner. The after treatment consisted in daily cleaning the wound with carbolic acid acidulated warm water. At the expiration of eight weeks the wounds were entirely healed and the swelling gradually disappeared until the parts resumed their normal appearance.

Now after a lapse of five months there are no evidences of any return of the trouble, and the success attending the treatment following this case has been repeated with a considerable number of patients since then, treated in like manner.

The Station Entomologist is very differently situated from any other member of the staff, inasmuch as his time and work are under the immediate control of the Entomological Division of the Department of Agriculture, which Division claims first use of all original work, the results of which must be first published in the Department's regular publications. The work is, however, done at the Station, largely with facilities furnished by us, and we utilize such results as are deemed of advantage to the community, in whose interest we are laboring. A very large amount of material, however, prepared by the Entomologist is never utilized in Station bulletins. It seems but just, however, that the Station publicly records the results of such work.

Opportunity is therefore taken to here enumerate the published results of Entomological work done at the Station during the past year, and not heretofore included in Station publications:

"Some injurious and beneficial insects of Australia and Tasmania. Notes on some species of insects which affect the upper portion of the stems of

several grasses. Ligyrus gibbosus injuring carrots in Indiana. The sunflower a food plant of Rhodobaenus, 13-pundatus; the dingy cut-worm (agrotis subgothica haw) destroying strawberries. The effect of arsenical insecticides upon the honey bee. Does the wheat-stem maggot (maromyza Americana) discriminate between different varieties of wheat. Dynastes tityus in Indiana. The field cricket destroying strawberries. Notes on the breeding and other habits of some species of curculionidæ, especially of the genus tyloderna. Southern spread of the Colorado potato beetle. Life history of one of the corn-bill bugs (sphenophorus ochreus lec). Early occurrence of the periodical cicada Experiments in rearing the plum curculio from plums and other fruits. Report of observations upon insects affecting the cereal grains. Notės on the following: The wheat strawworm; wheat stem-maggot; western striped cut-worm; the army worm; a new cut-worm; crambue zeellus; white grub; varying anomala; wheat wire-worm; drasterius elegans fab; 12-spotted diabrotica; the new cornbill bug; the chinch bug; the grain aphis; experiments on rearing the plum curculio; cimbex Americana in Nebraska; the Tarmanian lady beetle vs. the American blight; a podurid which destroys the red rust of wheat; a case of excessive parasitism; some unrecorded enemies of the raspberry and blackberry insects affecting salsify."

THE STATION'S RELATIONS TO FARMERS.

The Indiana Experiment Station having been founded for the express purpose of rendering assistance to the farmers of Indiana, the success of the Station depends, to a very considerable degree, upon the relations existing between Station and farmer clientage, and must be measured by the attitude taken by the farmers of the State toward this, their own special institution. What these relations have been during the past year must therefore furnish the truest indication of the results to be accomplished in the future and the most exact criterion by which the degree of success thus far attained may be measured. The most forcible evidence of the interest taken in our work by the farming community of the State, and their appreciation of our attempts and facilities for rendering them assistance, are furnished by the fact that several times, in addition to the constant queries propounded, farmers in different parts of the State have requested assistance, which has led to the investigation of special problems not embraced in our original scheme of work. As illustrations of work thus undertaken may be enumerated, our investigation of stinking smut, conducted in response to a request from farmers in Lagrange County, and resulting in the publication of Bulletin No. 28, met with a very gratifying approval from all parts of the State.

Bogus soils form another subject, in like manner, undergoing investigation in response to direct appeals made us by a considerable number of farmers from various localities. The study of chinch bug cholera and its

utilization as a protection against the depredations of the insect it attacks, was likewise begun at the request of a farmer of Warrick County, the results of which really exceeded our most sanguine expectations.

A disease attacking grapevines to the great injury of the crop along the Ohio river, was likewise investigated at the instigation of grape growers in that portion of the State. Each of the instances thus recorded has resulted in demonstrating the ability of the Station to render practical assistance to the agricultural community of the State, as well as the farmers' recognition of the fact and their desire, nay, determination to avail themselves of the advantages at their disposal.

In coming in contact, as the Director has endeavored to personally do, with the farmers in every different part of the State, particularly at the Farmers' Institutes, so largely attended and ably supported by them, he has been more than gratified at the invariable and exceeding interest manifested in the work of the Station and the appreciation to its fullest extent by the farmers of the State of the possibilities lying before them through the exertions of the Experiment Station.

So far as it is possible to judge, the attitude of the farmers of the State toward the work of the Station is one of unqualified support, and during the year not a single expression antagonistic to the work of the Station has come to our notice, nor has any expression of unbelief been publicly made in any gathering of farmers where the work of the Station has been discussed.

RECOGNITION OF THE WORK OF THE STATION.

As an indication that the work of the Experiment Station has received commendation at the hands of the public in whose interests its efforts are made, and the exact character of the recognition afforded, the following extracts from private letters received by the Station and from the press of the State are offered in evidence:

DEPARTMENT OF AGRICULTURE,
OFFICE OF ASSISTANT SECRETARY,
WASHINGTON, D. C., July 8, 1889.

HORACE E. STOCKBRIDGE, PH. D.,
Director Agricultural Experiment Station, LaFayette, Ind.:

DEAR SIR—In our investigations relating to wheat, its culture, etc., etc., there are no more satisfactory experiments than those of the Indiana Station. I am much pleased with your work. Have you any suggestions to make with reference to varieties that we should purchase for gen-

eral distribution? Are any of the varieties tested by you, in your judgment, worthy of such purchase? If so will you please indicate which ones and from whom we may be able to purchase the seed.

Any suggestions that may be in your power to give with reference to the subject matter will be carefully considered.

Yours truly, EDWIN WILLITS,
Assistant Secretary.

Official report of the Weather Observer at Seymour, Jackson County, Indiana, also published in the Seymour *Democrat*, July, 1889:

"Acting upon the kindly advice furnished by the Agricultural Experiment Station to the effect that thorough drying would restore damp wheat to its normal condition and prevent the propagation of weevil, our farmers have saved many thousands of bushels that would otherwise have been seriously damaged or lost."

I may add that a very large proportion of the wheat of Jackson County was injured by heavy rains during the time of harvest and thrashed in a damp condition. The wheat ware-house men refused to take the wheat at more than about three-fourths of the ruling market price and refused to allow the farmers to sun-dry the grain, alleging that propagation of the weevil would result. The point at issue was referred to the Station, with the result as inferred above of enabling the farmers to market their grain at full market rates. The actual extent of the pecuniary value of the interference of the Station may be estimated from the fact that the wheat yield of Jackson County is estimated at approximately 250,000 bushels.

Letter to the *Indiana Farmer* of April 6, 1889, referring to Bulletin No. 21 of the Station, signed Robert Jones:

"A copy of this bulletin in the hands of any farmer would be of great value to him, and if in the hands of every farmer of Indiana and its teachings were heeded, it would every year add more to the wealth of the State than the entire amount of all the expenditures of the State to the present time in building up and sustaining Purdue University."

"Our correspondent is correct in his estimate of Bulletin No. 21."—*Editors Indiana Farmer.*

President Albert Hall, of the Laporte County Farmers' Institute, publicly stated in the session of the Institute on December 18, 1889, that Bulletin No. 28 of the Station, offering protection against the smut of grains, would be worth annually more than $10,000 to the farmers of Laporte County alone. Wm. H. Temme, Esq., of Canal, Warrick County, who was supplied with the germs of chinch bug cholera by this Station, writes that by the assistance thus rendered through the Station his entire corn crop was entirely protected from the ravages of the pest, which previous to the interference of the Station threatened the total destruction of the crop.

A further evidence of the recognition of the true character of the work of the Station on the part of the farming community is offered by the growth of the Station mailing list, embracing the names of the regular farmer recipients of the Station publications.

January 1, 1889, although bulletins had been published under the auspices of the congressional act for an entire year, the mailing list contained but 800 addresses of farmers. January 1, 1890, the proportions of this same list had increased to 4,000 addresses. These addresses, it may be added, have been voluntarily forwarded to the Station by thirty-two hundred farmers of the State in a single year, with the request that all station publications be furnished them, in compliance with the law of Congress; most favorable evidence of a positive recognition from the farmers of the State of the utility of the Station. This growth has not been the result of a sweeping of the State for the procuring of postoffice addresses, our opinion being that more good will result through the utilization of our publications by one farmer who desires them sufficiently to personally request them than through their haphazard distribution to a hundred farmers without individual request. Our only attempt at increasing the number of recipients of bulletins being simply a plain statement of the actual work of the Station before various farmers' organization throughout the State.

The figures here given apply only to farmers in Indianá alone. It may be stated, however, that there is not a State or Territory in the Union from which requests for bulletins have not been made by farmers during the year.

These statements of actual facts are made for the sole reason of controverting aspersions occasionally cast upon experiment stations and intelligent farmers by usually well informed agricultural journals, of which the following extract, taken from a leading farm journal of an adjoining State, and published in September, 1889, serves as a sample: "So far, outside of a few farmers in New England who farm in a small way, and who claim to have derived some benefit from the experiment stations, we have yet to hear of a single farmer in the great farming regions of the Middle States, or the great West, that he has been materially benefited by the experiments made for him by a beneficent government. Perhaps these experiment stations are too young; that is, they have not had time to impress the farmers of their respective States with the importance and value of their work, and that, therefore, their influence is yet unfelt. This is true in a measure. And yet we apprehend that there may be something in the modus operandi of the stations themselves that debars farmers from receiving the intended benefit."

The Agricultural Experiment Station of Indiana in Account with the U. S., Year ending June 30, 1889.

DR.		
To balance, June 30, 1888	$87 09	
To appropriation	14,912 91	
		$15,000 00
CR.		
Supplies	$1,411 80	
Repairs.	155 55	
Apparatus and fixtures	1,306 94	
Printing, stationery and bulletins.	824 41	
Books	161 83	
Salaries of Staff	6,158 63	
Salaries of Assistants	1,173 39	
Farmers' Institute expenses	110 25	
Labor	2,777 68	
Postage.	82 00	
Express, freight and drayage	194 17	
Stock	102 00	
Gas	79 20	
Traveling expenses.	239 45	
Sundries unclassified	210 98	
Balance unexpended	11 72	
		15,000 00

The above is a correct statement of the receipts and expenditures of the United States Government Fund of the Agricultural Experiment Station of Indiana, as taken from my books.

E. A. ELLSWORTH,
Secretary of Board of Trustees.

Improvement Fund, Experiment Farm, Year ending June 30, 1889.

DR.		
Balance unexpended June 30, 1888.	$264 08	
Receipts from sale of farm products.	1,774 22	
CR.		
Heating apparatus		$500 00
Dry wells.		22 79
Plumbing Station building.		22 61
Building Lysimeter and coal shute		63 35
Repairs to barn		22 79
Work on Station building.		106 24
Lumber for boiler room.		22 64
Balance unexpended		1,277 88
	$2,038 30	$2,038 30

The above is a correct statement of the Improvement Fund of the Agricultural Experiment Station of Indiana, as taken from my books.

E. A. Ellsworth,
Secretary of Board of Trustees.

In conclusion, I beg to state that, as the result of one year's work with the Station, I am convinced that, though mistakes have, perhaps, been many, and results not always what were hoped for, the work has been, all things considered, exceedingly encouraging, and that a well-recognized beginning has been made toward the accomplishment of results of definite value to the farmers of Indiana, and that the brightest outlook is before the Station, evidenced, particularly, by the attitude of the farmers toward the Station.

We have recognized the fact from the beginning that the great field of agricultural research could never be covered by one station, and that concentration of energy in ours, as well as in every other undertaking, was absolutely essential to the highest success. Though we sincerely hope to be able to meet all actual demands upon our resources, we have attempted but few things at a time, but propose to do those well. We shall make one thing at a time, and one only a specialty.

Indiana is pre-eminently a wheat-producing State; we have been, therefore, thus far, pre-eminently a wheat-studying station, and the result of our work with this crop has not only added to our knowledge of the conditions underlying successful cultivation, but has furnished producers with positive protection against several serious enemies of the crop. We have, moreover, shown the relations between wheat production and certain other

farm crops. Having accomplished recognized results with wheat, it is our intention to turn next to some other crop of importance, and predominating cultivation in the State, giving the season during which crops are not grown to the utilization of these crops by farm animals, and thus gradually, but constantly, broaden the scope of our work and the possibilities of accomplishment.

Pursuing these methods, recognizing, however, the element of time necessarily required for the attainment of a definite end in agricultural investigation, it is not only our hope, but expectation as well, to ultimately reach the great mass of farmers of our State, and practically demonstrate to them the availability and benefits of the work undertaken solely in their interests.

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PURDUE UNIVERSITY.

THIRD REPORT

OF THE

Agricultural Experiment Station,

LAFAYETTE, INDIANA.

1890.

PURDUE UNIVERSITY.

THIRD REPORT

OF THE

Agricultural Experiment Station,

LAFAYETTE, INDIANA.

1890.

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WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.
1891.

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EDWARD A. ELLSWORTH	Secretary.
JAMES M. FOWLER	Treasurer.

STATION STAFF.

JAMES H. SMART, LL. D	Acting Director.
C. S. PLUMB, B. S	Vice Director.
WILLIAM C. LATTA, M. S	Agriculturist.
JAMES TROOP, M. S.	Horticulturist.
HENRY H. HUSTON, A. M., A. C.	Chemist.
JOSEPH C. ARTHUR, D. Sc	Botanist.
*FRANCIS M. WEBSTER	Entomologist.
THERIES D. HINEBAUCH, M. S., V. S	Veterinarian.
ARTHUR GOSS, B. S., A. C.	Assistant Chemist.
KATHERINE GOLDEN, B. S.	Assistant Botanist.

*Prof. Webster is located at Purdue University as special agent of the United States Department of Agriculture, Division of Entomology.

THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT.

Report of Purdue Agricultural Experiment Station, due February 1, 1891, was filed in the office of the Governor of Indiana January 29, 1891.

W. B. ROBERTS,
Private Secretary.

To the Governor of Indiana:

I herewith present the Annual Report of the Agricultural Experiment Station of Indiana, due on or before the 1st of February, 1891, the same being required by section 3 of an act entitled "An act to establish agricultural experiment stations in connection with the colleges established in the several States, under provisions of an act approved July 2, 1862, and of the acts supplementary thereto."

This report consists of a report of the Vice Director of the station, and the financial report of the Secretary of the Board of Trustees.

Respectfully submitted,

J. H. SMART,
President.

Purdue University, Lafayette, Ind., Jan. 28, 1891.

THIRD ANNUAL REPORT

Purdue University Agricultural Experiment Station,

FOR THE YEAR 1890.

REPORT OF THE VICE DIRECTOR.

To the President, J. H. Smart:

During the year 1890 the work of the station has been industriously carried forward. Early in June Dr. H. E. Stockbridge, the Director, resigned that position, and since that time the executive work of the station has been in my charge as the Vice Director, as I assumed that position on May 1st. Mr. H. L. Bolley, who acted as Assistant Botanist, also terminated his connection with the station on August 1st to accept a position elsewhere. Miss Katharine Golden, a graduate of Purdue, was appointed to fill the position made vacant by Mr. Bolley.

BUILDINGS AND EQUIPMENTS.

A portion of the special State appropriation for the station has been employed the past year in erecting five additions, in the form of buildings, to our equipment: (1) A dairy building which contains a general work room, milk setting room, ice house and cheese curing room. This building is especially constructed for experimental work and also for practical purposes. (2) A tool house. (3) An addition to the farm house. (4) An experimental greenhouse. The foundations of this greenhouse are built, but the superstructure is not yet erected, though partly on the grounds. (5) A veterinary building in which animal diseases can be investigated.

But a comparatively small amount of apparatus has been purchased during the year, the expenditures tending rather toward laboratory supplies for carrying on current work.

INVESTIGATIONS.

The experimental work in progress during the year is reported upon in the following reports of the members of the station staff, which is a brief synopsis, intended simply to show what the line of work is that is being pursued in the different departments.

In the feeding barn, late in the year, two series of experiments, intended to extend through the winter, were begun to study the influence of food stuffs upon the animal system.

The Veterinarian of the station undertook a study of hog cholera and tuberculosis, but this work was discontinued, owing to a lack of material.

PUBLICATIONS.

Four bulletins have been issued during the year, as outlined below:

No. 30, February, 1890, pp. 11. Influenza, by T. D. Hinebauch.

No. 31, April, 1890, pp. 22. Small Fruits and Vegetables, by James Troop.

No. 32 (vol. II) July, 1890, pp. 22. (1) Treatment of Smut in Wheat, by J. C. Arthur. (2) Field Experiments with Wheat, by W. C. Latta. (3) A Note on Two Inferior Fertilizers, by C. S. Plumb.

No. 33 (Vol. II), October, 1890, pp. 23–54. (I) Small Fruits, by J. Troop. (2) Entomological Notes, by F. M. Webster. (3) The Absorptive Power of Soils, by H. A. Huston.

REPORT OF THE BOTANICAL DEPARTMENT.

The work of the Botanical Department of the Station has been directed during the year 1890 to carrying out, with more completeness and greater exactness, some of the lines of work planned and begun in the two preceding years, and in addition has undertaken some new subjects.

CORN.

The data from corn raised in 1889, from weighed kernels, have been completed during the last year. From the results it has been learned that on all the ears weighed (of white dent corn) the heaviest kernels

are at the butt of the ear and decrease in weight with much uniformity from butt to tip. The yield of shelled corn was strongly in favor of the plantings from the heaviest kernels.

OATS.

Considerable attention has been devoted to the practical benefits to be derived from the treatment of seed oats to a short immersion in very hot water. The data and conclusions to be drawn from this series of experiments are now in manuscript form awaiting publication as a bulletin. In brief, it wa learned that seed grain lost 2½ to 3½ per cent. in weight by being placed in water ranging from 120° to 150° F. for three to twenty minutes. Seeds thus treated, however, invariably germinated more rapidly than untreated seed, amounting on an average to half a day acceleration under the specially favorable conditions of the laboratory test. In the field the difference in rate of growth is readily seen for some time after the plants are above the surface of the ground. The advantage gained at the beginning of the season is not lost, although it can not long be followed by the eye. At harvest time the crop from the treated seed was found to average an inch taller than the other and to afford about 7 per cent. heavier yield. The season was an unfavorable one for oats, and it is thought that under better conditions of growth a still more marked difference between the treated and the untreated seed would be evident.

The hot water treatment of oats was undertaken primarily to find a means for preventing the smut, which proves a much greater source of loss to the Indiana farmer than is usually recognized, being from 8 to 12 per cent. of the crop upon an average. The result of this work has been thoroughly successful, and one of the most simple and inexpensive remedies known in the whole range of plant diseases can be confidently recommended by which an annual loss of $800,000 in the oat crop can be saved to the farmers of the State by the expenditure of a trifling amount of time and trouble and of no cash. The method to be pursued is to immerse the seed-grain for five minutes in water at 135° F. If the temperature of the water fluctuates the seed is to be left in the water a shorter time as the temperature rises and a longer time as it falls, but a variation of more than five degrees above or below 135° should not be allowed.

It is found that the beneficial effects follow from seed sown any time after treatment up to three months and probably longer. The treatment need not, therefore, be left to the day before sowing, but may be performed at any time that it is found convenient.

WHEAT.

Experiments similar to those upon oats have been carried out with wheat, but are not yet so far along. The most important results have already been given to the public in bulletin 32, issued last July, and, in the main, accord with what has just been said regarding oats.

POTATOES.

The most extensive and elaborate experiments of the year have been directed to the study of the physiological relation between the tuber and the yield, and of the etiology of scab.

As the orderly arrangement of the data for the physiological part is not yet completed, it is only possible at this time to present a few of the questions that have been under consideration. These questions relate to the advantage to be gained by planting large or small tubers, whole or cut, more or less seed material in a hill, cut immediately or at some time before planting, differences in the eyes due to location on the tuber, and the number of shoots in the hill.

Regarding the cause of scab, most important results have been obtained. It has been ascertained beyond a doubt that the scab is due to parasitic germs entering the tuber while it is yet growing, and by their action bringing about the destruction of the tissues, giving rise to the appearance known as scab. The germs are usually introduced into the hills with the tubers, but undoubtedly persist in rich soil from season to season. This part of the work was done by Mr. H. L. Bolley while assistant botanist, and the main results with the history of the subject have been published in "Agricultural Science" for last September and October. Further work is required to apply the technical results so far obtained to devising means for practically preventing the appearance of the scab in the field.

PEAS.

Both garden and sweet peas have been used to test the question of the relation of the weight of the seed to production, but the data are not yet in order.

TOMATOES.

The inquiry into the disturbance in development of the plant brought about by using immature seeds, has been continued during the last year, and is yet incomplete. A difference of three weeks in earliness of ripening for the first ten fruits was recorded in favor of the strain grown for five generations from immature seed over a similar strain from mature seed. Only a slight difference in this respect was obtained from plants grown from mature and immature seed, of but one season's selection.

CARNATIONS.

The cause of an important disease of carnation pinks, when grown in the greenhouse for cut flowers has been satisfactorily traced to specific germs. These have been separated and cultivated in the laboratory and the disease produced in healthy plants by artificial inoculation. The results of the study are now in manuscript. A further prosecution of the subject in order to ascertain a practical prevention is contemplated.

Quite a number of inquiries of minor importance have been taken up from time to time, which it is not necessary to specify in this connection.

J. C. ARTHUR,
Botanist.

REPORT OF CHEMICAL DEPARTMENT.

The following is a brief, synoptical report of the work of the Chemical Department of the Experiment Station for the year 1890:

Fodder analyses (completed)	31
Fodder analyses (under way)	11
Edible puff balls, extended examination	1
Fertilizing ingredients in farm crops (analyses)	11
Milk analyses	28
Sugar beet analyses	121
Tankage	1
Examination of cream tartar	1
Seed germinator examined	1
Fertilizers inspected for farmers	9
Analyses of manure	2
Nitrogen estimations in corn	79
Phosphoric acid in aluminic phosphate	79
Phosphoric acid in bone meal	42
Examination of apples	1
Special extraction of fat in cattle food	92
Comparison of C. P. and Commercial Citrate in determining reverted phosphoric acid in Commercial fertilizers	6
Examination of sand	1
Oil meal inspected	1
Examination of lime	2
Examination of marl	1

A large number of specimens of various kinds have been sent in for examination, which required no chemical work, but merely a statement of the character of the material. Much work has been done on aluminic phosphates, a material that is coming into use in commercial fertilizers, and which differs materially from mineral phosphates in its behavior toward the re-agents used in obtaining the valuation of phosphates. It is also believed that the work on fats in feeding material will prove of permanent value.

Experiments were begun in the fall to determine the form of nitrogen best adapted to wheat, and also to determine whether the form is the same at all stages of growth.

Fourteen varieties of fungi have been collected and prepared for analysis, with a view of determining their nutritive value.

I believe that the work on sugar beets, which has been in progress for the last three years, and which will be continued, will prove of the highest value to the agricultural interests of the State.

H. A. HUSTON,
Chemist.

REPORT OF THE AGRICULTURIST.

The following is a synopsis of the work conducted by the Agriculturist during the year 1890:

I. TESTS OF VARIETIES.

1. Wheat—Thirty varieties of wheat were grown under like conditions in the open field. Time of heading, maturing, and characteristics of straw and head noted; also weight per measured bushel, and yields of straw and grain per plot and per acre.
2. Corn—Twenty-seven varieties were grown side by side under like treatment. Average height of ear and of entire stalk, time of appearance of staminate and pistillate flowers, time of maturing, per cent. of suckers and of smutted stalks, as well as the weight of grain and stalks at husking time, were all noted and recorded. Samples of ears were reserved to determine the percentage of shrinkage and the per cent. of shelled corn.

II. Tests of Rates of Seeding.

1. Wheat—Rates of seeding were used, ranging from two pecks per acre to eight pecks, and the yields per acre of grain and straw noted.
2. Oats—Rates of seeding ranged from four pecks per acre to twelve pecks. This experiment was abandoned, owing to the serious lodging of the crop from frequent heavy rains with wind.

III. Tests of Early and Late Seeding.

1. Wheat—Dates of seeding ranged from September 20th to October 18th, one or more plats being sown each week. Time of maturing, length of straw and yields of straw and grain were recorded.
2. Oats—Dates of planting ranged from April 8th to April 22d, one or more plats being sown each week. This experiment was abandoned because of lodging of crop.
3. Corn—Dates of planting ranged from May 1st to May 29th. Yields of grain (ears), good and poor corn noted.

IV. Test of Fertilizer on Wheat.

A single brand was tried, with the result of a slight increase in yield and a net loss resulting from its use.

V. Test of Lasting Effect of Previous Fertilization on Yield of Corn.

Gas lime, ammoniated phosphate and fresh horse manure were applied in 1883 and in 1884, but not before or since. Corn has been grown on this plat every year since 1880. Effects of lime and phosphate have vanished, but the manure continues to show a fair increase in yield.

VI. Comparison of Continuous Grain Growing and Crop Rotation as to Effects on Yields of Grain.

On Series F are the rotations—5-course, 6-course and 7-course, each involving two years of grass in addition to grain crops. On Series H the same grain crop is grown continuously, or two grain crops are grown in alternation. No manure was used on either series. The experiment was begun in 1880. Series F is now producing better grain yields than Series H. All crops are entirely removed.

VII. TESTS OF FULL AND TWO-THIRDS APPLICATIONS OF COMPLETE FERTILIZERS AND MANURES, WITH VARIOUS SYSTEMS OF CROPPING.

1. Series 1—Cropping corn (1889) and wheat (1890) altertermately.*
   Plat 2 fertilized for 30-bushel yield of wheat per acre.
   Plat 3 fertilized for 20-bushel yield of wheat per acre.
   Plat 5 manured for 30-bushel yield of wheat per acre.
   Plat 6 manured for 20-bushel yield of wheat per acre.
2. Series II—Cropping, a 3-course, corn (1889), barley (1890), wheat (1891), clover to be sown with wheat, to be plowed under for corn.
   Plat 2 fertilized for 40-bushel yield of barley per acre.
   Plat 3 fertilized for 26-bushel yield of barley per acre.
   Plat 5 manured for 40-bushel yield of barley per acre.
   Plat 6 manured for 26-bushel yield of barley per acre.
3. Series III—Cropping, wheat grown continuously, fertilizing and manuring same as 1.
4. Series V—Cropping, a 4-course, corn (1889), oats (1890), wheat (1891), clover (1892).
   Plat 2 fertilized for 50-bushel yield of oats per acre.
   Plat 3 fertilized for 33-bushel yield of oats per acre.
   Plat 5 manured for 50-bushel yield of oats per acre.
   Plat 6 manured for 33-bushel yield of oats per acre.
5. Series VI—Cropping, a 6-course, corn (1889), beets (1890), oats (1891), wheat (1892), grass (orchard and clover) two years (1893 and 1894).
   Plat 2 fertilized for 12 tons beet roots per acre.
   Plat 3 fertilized for 8 tons beet roots per acre.
   Plat 5 manured for 12 tons beet roots per acre.
   Plat 6 manured for 8 tons beet roots per acre.
6. Series VII—Cropping, clover grown continuously. Land plaster, potash and manure applied to separate plats—enough of each for a three-ton crop.

VIII. TESTS OF COMPLETE AND PARTIAL FERTILIZATION, WITH ROTATION OF CROPS.

Series IV—Cropping, a 5-course, corn (1889), oats (1890), wheat (1891), grass (timothy or clover) two years (1892 and 1893). The amount of fertilizer or manure, or of one or more ingredients of a complete fertilizer, was in each case sufficient for a 50-bushel yield of oats per acre.

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*The plan to be followed is as above, though this years' experiments (1890) were not exactly as given above.

Plats 2, 3 and 4 devoted to a test of complete manures and fertilizers.

Plats 6, 7 and 8 devoted to a test of two ingredients of complete fertilizers.

Plats 10, 11 and 12 devoted to a test of one ingredient of complete fertilizer.

Plats 14, 15 and 16 devoted to a test of lime plaster and salt (30 pounds each), or at the rate of 300 pounds per acre.

Experiments I to VI, inclusive, were begun several years ago.

Experiments VII and VIII were begun in 1889. The aim of the latter is to determine eventually the combined effect of fertilization and cropping on the ground, and on quality and yield of crop.

W. C. LATTA,
Agriculturist.

REPORT OF THE HORTICULTURIST.

The following is a synopsis of the work done by the Horticulturist for 1890:

FRUITS.

1. Tests of varieties of orchard fruits. This was commenced in 1886, when there were planted out 15 varieties of plums, 18 of cherries, 2 of apricots, 2 of peaches, 11 of pears and 32 of apples.

In 1887, 17 varieties of apples were added and in 1888, 3 varieties of quince, 8 of plums, 7 of cherries, 12 of pears and 49 of apples, making 176 in all, mostly new varieties. A portion of the plums and cherries have borne three crops of fruit while some bore this year for the first time. Ten varieties of apples bore their first crop of fruit this year, some of which are very promising. Owing to the extremely mild winter peach and apricot buds began to swell in February and were nearly all killed by the freezing weather in March.

2. Tests of varieties of small fruits. This included 108 of strawberries, 28 of raspberries, 28 of blackberries, 9 of currants, 4 of gooseberries and 33 of grapes. Date of blossoming, date of ripening, vigor of plant, hardiness, size, productiveness, quality and firmness were all noted.

3. Cross-fertilizing strawberries and producing new varieties from the seeds. These have borne no fruit as yet.

4. Observations on peach-trees which were raised from pits taken from fruit affected with the "yellows." To determine whether the disease is transmitted through the seed. Too early for results as yet.

5. A comparison of healthy, seedling peach-trees, with the same budded with diseased buds. To determine to what extent the "yellows" may be transmitted by using diseased buds. Two large trees began to show signs of disease this season.

VEGETABLES.

6. Tests of varieties of potatoes. Eighty-three varieties were planted and given the same cultivation throughout the season. Date of blossoming, date of ripening, yield per acre of marketable and unmarketable potatoes were all recorded.

7. Noting the effects of planting a different number of eyes in a hill. Tubers selected for uniformity in size, and cut in pieces ranging from one eye to five. These were compared with a whole tuber, and the yield per acre in each case noted.

8. Noting the result obtained from planting potatoes cut in single eye pieces, as compared with the same number of eyes cut in a single piece. Yield carefully recorded.

9. Large *vs.* small potatoes for planting. A whole large tuber planted alongside a whole small one (one-fourth the size of the larger). Planted in hills and given hill culture.

10. Testing trench *vs.* hill culture. To determine which is preferable.

11. Testing "seed ends," middle and stem ends of the potato, by dividing it into thirds before planting. To ascertain which is preferable for planting.

12. Testing the value of sprouts of the potato for planting, by breaking them off from the tuber after they have become six to eight inches long, and planting as is customary with sweet potatoes.

13. Tests of 50 varieties of sweet corn, obtained from different sources and given like conditions. The per cent. germinating, date of blossoming, date of edibility, quality and comparative yield were all noted.

14. Tests of 30 varieties of garden peas, all obtained from one firm. Same notes taken as in No. 13.

15. Tests of eight varieties of sugar beets. To determine their sugar producing qualities.

16. Testing the comparative value of "Paris green," "London purple" and "arsenite of ammonia," as insecticides, the latter being a new compound sent out this season. It is claimed to answer every purpose for which Paris green is used, while the cost is very much less.

17. Besides the foregoing, a large number of varieties of fruits have been tested at the ten sub-stations located in different portions of the State, reports from which have been received and recorded.

JAMES TROOP,
Horticulturist.

Respectfully submitted,

CHAS. S. PLUMB,
Vice Director.

The Agricultural Experiment Station of Indiana in account with the United States for the year ending June 30, 1890:

Dr.

Balance June 30, 1889	$11 72
Appropriations	14,988 28

Cr.

Supplies	$1,280 74
Repairs	152 65
Apparatus and fixtures	504 56
Improvements	11 75
Printing, stationery and bulletins	1,198 08
Books	4 00
Care of buildings	1 90
Salary of staff	7,335 99
Assistants	670 46
Labor	2,923 02
Postage	72 85
Express, freight and hauling	63 93
Gas	138 60
Telegrams	19 07
Advertising	11 05
Miscellaneous	12 30
Insurance	17 60
Stock	359 00
Traveling expenses	34 35
Total	$15,000 00

The above is a correct statement of the general fund of the Agricultural Experiment Station of Indiana for the year ending June 30, 1890.

E. A. ELLSWORTH,
Secretary Board of Trustees.

Improvement fund, Experiment Farm, for year ending June 30, 1890:

Dr.

Balance unexpended June 30, 1889	$1,277 88
Receipts from sale of farm products	2,797 04

Cr.

Salary	$1,218 04
Employes	666 88
Apparatus and fixtures	34 97
Expense attending American Agricultural College Association	57 50
Farmers' institutes	14 20
Books	71 00
Insurance	50 00
Repairs	38 88
Labor	771 67
Supplies	656 01
Printing and stationery	51 50
Improvements	26 25
Advertising	5 00
Balance unexpended	413 02
Total	$4,074 92

The above is a correct statement of the improvement fund for year ending June 30, 1890.

E. A. Ellsworth,
Secretary Board of Trustees.

PURDUE UNIVERSITY.

FOURTH ANNUAL REPORT

OF THE

Agricultural Experiment Station,

LAFAYETTE, INDIANA.

1891.

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.
1891.

PURDUE UNIVERSITY.

FOURTH ANNUAL REPORT

OF THE

Agricultural Experiment Station,

LAFAYETTE, INDIANA.

1891.

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.
1892

BOARD IN CONTROL.

Dec. 31, 1891.

CHARLES B. STUART, President.....................Lafayette.
WILLIAM A. BANKS,....................................Laporte.
JASPER N. DAVIDSON,................................Whitesville.
ULRIC Z. WILEY,...Fowler.
SYLVESTER JOHNSON,.................................Irvington.
DAVID E. BEEM,..Spencer.

JAMES H. SMART, LL. D., President of the University.

EDWARD A. ELLSWORTH, Secretary.

JAMES M. FOWLER, Treasurer.

STATION STAFF.

Dec. 31, 1891.

C. S. PLUMB, B. S.................................Director.
WM. C. LATTA, M. S.................................Agriculturist.
JAMES TROOP, M. S.................................Horticulturist.
HENRY A. HUSTON, A. M., A. C...............Chemist.
JOSEPH C. ARTHUR, D. Sc.........................Botanist.
W. L. WILLIAMS, D. V. S..........................Veterinarian.
ARTHUR GOSS, B. S., A. C........................Assistant Chemist.
KATHERINE E. GOLDEN, B. S....................Assistant Botanist.

To the Governor:

I herewith transmit the Annual Report of the Purdue Experiment Station, due February 1, 1892.

Very respectfully,

C. B. STUART,
President Board of Trustees.

JANUARY 26, 1892.

To the President of the Board of Trustees:

I herewith present the Annual Report of the Agricultural Experiment Station of Indiana, due on or before the first of February, 1892, the same being required by section 3 of an act entitled "An act to establish agricultural experiment stations in connection with the colleges established in the several States, under provisions of an act approved July 2, 1862, and of the acts supplementary thereto."

This report consists of a report of the Director of the station, and the financial report of the Secretary to the Board of Trustees.

Respectfully submitted,

J. H. SMART,
President.

Purdue University, Lafayette, Ind., January 25, 1892.

FOURTH ANNUAL REPORT

—OF THE—

Purdue University Agricultural Experiment Station

FOR THE YEAR 1891.

REPORT OF THE DIRECTOR.

To President James H. Smart:

As Director I have the honor to render you the following report concerning the Experiment Station of Purdue University during 1891:

Early in June, I was officially made Director of the Station by the Board of Trustees, although as Vice-Director I had supervised the affairs of the Station from the first of the year. On July 1 Dr. S. S. Twombly, Veterinarian, resigned that position to accept a chair in the agricultural college at Logan, Utah. The vacancy caused by Dr. Twombly's resignation has been acceptably filled since September 1 by Dr. W. L. Williams, of Bloomington, Ill., a graduate of the Veterinary School of McGill University, and a practicing veterinary surgeon of twelve years' experience. Mr. F. M. Webster, who has for some years acted as Entomologist to the Station, under the direction of the Division of Entomology of the United States Department of Agriculture, whose official he was, was on July 1 transferred to the Ohio Experiment Station, at Columbus. These are the only changes in the personel of the Station staff

during the year 1891. The above changes caused no essential disturbance of work. The Veterinary Department was never better officered or equipped than at the close of this year, and active investigation is now in progress as never before. While the Station received material benefits from the work of Mr. Webster as the agent of the United States Department of Agriculture, his research was controlled by it, consequently the severance of his relations with the Station did not interrupt work in the control of this institution. However, in view of the great ravages caused by insects, I should deem it a judicious move for this Station to secure the permanent services of a competent economic entomologist. The amount of experimental investigation that may be conducted toward restricting or preventing the ravages of the Hessian fly, chinch bug, various cut-worms, cabbage fly and numerous other very destructive insects is almost unlimited. The experimental orchard has now reached a growth where insects injurious to fruits will cause much trouble, consequently it will furnish a suitable field for experimental work in entomology.

INVESTIGATIONS.

Owing to a constantly improving equipment, and more and more systematic methods, the work of the Station has materially improved, and while there is a considerable field covered in experimental research by the Station staff, I wish to especially call your attention to the following lines as promising important, far reaching results.

A study has been made for several years, bearing upon the suitability of Indiana as a sugar beet producing State. Beets have been grown by farmers, under Station supervision, covering the entire northern half of the State, as well as some points in the southern half. It is gratifying to be able to state that results lead to the belief that sugar may profitably be made from beets in Indiana, from favorable soil, climatic and other conditions, among the more important of the latter of which may be mentioned the geographical location of the State as a distributing point.

In view of the large wheat interests of Indiana, important investigations are being conducted by the chemical department relating to the application of nitrogenous fertilizers upon this

crop. The experiments of the Agriculturist covering years of repetition work on the cereals generally, are also worthy of comment. The constant duplication of experiments from year to year on the influence of plant food, tillage, cropping, etc., is the most satisfactory method of field work, and this system is in active operation in our experiments on the cereals and the grasses generally.

In the Botanical Department three plant diseases of importance are being investigated, and already much has been accomplished of a practical nature for public benefit. The diseases are (1) grain smut (especially wheat and oats), (2) a bacterial disease of the sugar beet, and (3) carnation diseases.

In the Veterinary Department special investigations are in progress concerning Actinomycosis or Lumpy Jaw of cattle.

In the feeding of live stock, experiments upon steers relate to the influence of the physical condition of the rough food upon meat production; calves are receiving comparative rations of whole and skim-milk; and pigs are being fed comparatively on corn in different forms, and on rations designed for producing in the one case lean and in the other fat meat.

A considerable portion of the above experimental work will be presented to the public in bulletin form during the year 1892.

PUBLICATIONS.

The mailing list of the Experiment Station has been entirely reorganized and a new list established, the card catalogue system being adopted, this method being very satisfactory and enabling us to keep a proper control of the names of persons receiving the Station publications. Up to January 1, 1892, there have been placed 5,800 addresses on the new list.

Four bulletins have been issued during 1891, as below:

No. 34, Vol. II, February, 1891, pp. 55-80. (1) Sugar beets, by H. A. Huston. (2) Field experiments with commercial fertilizers and manure on barley and oats, by W. C. Latta. (3) Tests of vegetables, by Jas. Troop.

No. 35, Vol. II, March, 1891, pp. 80–107. Loose smut of oats, by J. C. Arthur.

No. 36, Vol. II, August, 1891, pp. 108–38. (1) Field experiments with wheat, by W. C. Latta. (2) Testing grain, by W. C. Latta. (3) Wheat scab, by J. C. Arthur. (4) Forms of nitrogen for wheat, by H. A. Huston.

No. 37, Vol. II, December, 1891, pp. 139–50. (1) Steer feeding. A comparison of cut with uncut clover, by C. S. Plumb. (2) Composition and valuation of Indiana feeding stuffs, by H. A. Huston.

In order to furnish the press with certain timely information of value, hardly necessitating the regular bulletin form, two newspaper bulletins, of one page each have been published, as follows:

No. 1. August 1, 1881. How to prevent smut in wheat.

No. 2. October 19, 1891. The foot and mouth affection of cattle.

As there is enough suitable material for publication during 1892, I recommend that at least six bulletins of experimental research be issued during the ensuing year.

ACKNOWLEDGMENTS.

During the year 1891 the following gifts have been presented to the Station, which I here take pleasure in acknowledging:

From Maj. L. C. Camp, Memphis, Tenn., a series of samples of products of the cotton seed oil mills.

From Francis Brill, Hempstead, N. Y., 11 packages of seeds.

From U. S. Department of Agriculture, four packets Chinese potato bulblets; 150 botanical specimens; numerous publications from different divisions of Department.

From Steel Bros. & Co., Toronto, Canada, wheat and carrot seed.

From John Horner & Son, Delair, N. J., melon and tomato seeds.

From J. C. Crossman, Wolcottville, Ind., potato samples.

From Riley & Baldwin, Thorntown, Ind., one-fourth bushel of barley seed, and samples of corn.

From F. Barteldes & Co., Lawrence, Ill., samples seed corn and melons.

From Wm. Henry Maule, Philadelphia, Pa., samples New Freeman Potato.

From N. J. Fleming, Tabor, Ind., yellow dent seed corn.

From Jas. Riley, Thorntown, Ind., samples seed corn.

From S. W. Dungan, Franklin, Ind., samples seed corn.

From Daisy Implement Co., Pleasant Lake, Ind., one hand cultivator and one hand plow.

From T. B. Terry, Hudson, Ohio, sample of wheat.

From Rock Island Plow Co., one hay rake and loader.

From Department of Agriculture, Ontario, Canada, annual report of department.

From Robert Warington, F. R. S., Rothamsted, England, 13 reports from Rothamsted Laboratory.

From Sir J. B. Lawes, Rothamsted, England, bound volumes of Memoirs of Rothamsted Experiment Station, nine in number.

The following periodicals have been sent gratuitously to the Station, for which we hereby express our thanks to the publishers:

Agricultural Epitomist	Indianapolis, Ind.
American Agriculturist	New York City, N.Y
American Bee Journal	Chicago, Ill.
American Garden	New York City, N.Y
American Grange Bulletin	Cincinnati, Ohio.
American Homestead	Omaha, Neb.
American Rural Home	Rochester, N. Y.
American Sheep Breeder and Wool Grower	Chicago, Ill.
American Swineherd	Chicago, Ill.
Baltimore Sun (weekly)	Baltimore, Md.
Breeders' Gazette	Chicago, Ill.
Chicago Herald (weekly)	Chicago, Ill.
Drainage Journal	Indianapolis, Ind.
Experiment Station Record	Washington, D. C.
Farm and Fireside	Springfield, Ohio.
Farm and Home	Chicago, Ill.
Farm, Field and Stockman	Chicago, Ill.
Farm Implement News	Chicago, Ill.
Farm Journal	Philadelphia, Pa.
Farmers' Advocate	London, Ont., Can.
Farmers' Call	Quincy, Ill.

Farmers' Home	Dayton, Ohio.
Farmers' Journal	Hornellsville, N. Y.
Farmers' Record	Muncie, Ind.
Farmers' Review	Chicago, Ill.
Hoard's Dairyman	Ft. Atkinson, Wis.
Holstein-Friesian Register	Boston, Mass.
Home and Farm	Louisville, Ky.
The Husbandman	Binghampton, N.Y.
Indiana Farmer	Indianapolis, Ind.
Industrial American	Lexington, Ky.
Insect Life	Washington, D. C.
Iowa Homestead	Des Moines, Iowa.
Jersey Bulletin	Indianapolis, Ind.
Journal of Agriculture	St. Louis, Mo.
Journal of Mycology	Washington, D. C.
Kansas City Live Stock Indicator	Kansas City, Mo
Kansas Farmer	Topeka, Kan.
Louisiana Planter	New Orleans, La.
Maritime Agriculturist	St. Johns, N. Bruns.
Michigan Farmer	Detroit, Mich.
Mirror and Farmer	Manchester, N. H.
Millstone and Corn Miller	Indianapolis, Ind.
Montana Farming and Stock Journal	Helena, Mont.
National Stockman and Farmer	Pittsburgh, Pa.
Nebraska Farmer	Lincoln, Neb.
New Dairy, The	New York City, N Y
New England Farmer	Boston, Mass.
Ohio Farmer	Cleveland, Ohio.
Pacific Rural Press	San Francisco, Cal.
Popular Gardening	Buffalo, N. Y.
Practical Farmer	Philadelphia, Pa.
Rural Home	Philadelphia, Pa.
Southern Cultivator and Dixie Farmer	Atlanta, Ga.
Sugar Beet	Philadelphia, Pa.
Wayne Farmer	Hagerstown, Ind
Western Plowman	Moline, Ill.
Western Swineherd	Geneseo, Ill.
Wisconsin Agriculturist	Racine, Wis.
Wisconsin Farmer	Madison, Wis.

Finally, I wish to state that the general work of the Station is being industriously conducted, and that all the members of the

staff are faithfully engaged in its interests. I respectfully call your attention to their appended reports, giving a synopsis of the work in hand in the different departments during the year 1891.

Respectfully submitted,

C. S. PLUMB,
Director.

REPORT OF THE AGRICULTURIST.

The work of the Agriculturist has been devoted largely during the year 1891, to carrying out field experiments previously begun. Two new lines of experiments have been inaugurated: First, to determine the effect of deep and shallow plowing; and second, coöperative experiments with varieties of wheat in various parts of the State. A brief synopsis of the year's work is shown below:

I. EXPERIMENTS WITH VARIETIES.

1. *Wheat*—Number of varieties tested in 1891, twenty-one; time under trial, one to eight years; average yields, twenty-five to forty-one bushels; yields in 1891, twenty-one to forty-four bushels; leading sorts, Velvet Chaff, Michigan Amber, Fulcaster, Early Red Clawson, Jones' Winter Fife.

2. *Corn*—Number of varieties tested in 1891, twenty-one; time under trial, two to five years; average yields, forty to seventy-four bushels; yields in 1891, thirty-four to seventy-six bushels; leading kinds, Purdue Yellow, Haben's Golden, Boone County White, Riley's Favorite, White Prolific, Yellow Nonesuch, Yellow Dent, Yellow Speckled.

3. *Oats*—Number of varieties tested in 1891, twenty-seven; time under trial, one to three years; average yields, thirty-four to seventy-one bushels; yields in 1891, thirty-one to seventy-four bushels; leading varieties, Wide-awake, White Russian, Probstier, Badger Queen.

II. EXPERIMENTS WITH THICK AND THIN SOWING AND PLANTING.

1. *Wheat*—Quantity of seed, two to eight pecks per acre; time under trial, seven years; range of average yields, twenty-two to thirty-one bushels; range of yields in 1891, twenty-nine

to forty bushels; highest average yield produced from eight pecks per acre; lowest average yield produced from two pecks per acre.

2. *Oats*—Quantity of seed, four to twelve pecks per acre; time under trial, six years; range of average yields, forty-five to fifty bushels; range of yields in 1891, forty-three to fifty-four bushels; highest average yield produced from eight pecks per acre; lowest average yield produced from five pecks per acre.

3. *Corn*—Thickness of stand ranged from ten to twenty inches between individual stalks planted in drills; time under trial, five years; range of average yields, forty-eight to fifty-six bushels; range of yields in 1891, forty-one to fifty-eight bushels; highest average yield produced from stalks fourteen inches apart; lowest average yield produced from stalks twenty inches apart.

III. EXPERIMENTS WITH EARLY AND LATE SOWING.

Wheat—Range of dates, September 18th to October 16th; time under trial, three years; range of average yields, twenty-three to thirty-five bushels; yield from earliest sowing, thirty-five bushels; yield from latest sowing, twenty-three bushels.

IV. EXPERIMENTS WITH LARGE AND SMALL SEED WHEAT.

The large seed was that which passed *over* the seed screen of the fanning-mill, and the small seed that which passed *through* said screen. Time under trial, three years; quantity of seed sown per acre, one and one-half bushels on all plats; average yield from small seed, twenty-eight bushels; average yield from large seed, thirty and one-half bushels.

V. EXPERIMENTS WITH DEEP AND SHALLOW PLOWING.

This experiment was commenced in the spring of 1891; range of depth of plowing, four to twelve inches; crop grown, Indian corn; results thus far not decisive. These plats had in previous years all been plowed about eight inches deep. All the plats received a liberal manuring in the spring of 1891.

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IV. EXPERIMENTS WITH LARGE AND SMALL SEED WHEAT.

The large seed was that which passed *over* the seed screen of the fanning-mill, and the small seed that which passed *through* said screen. Time under trial, three years; quantity of seed sown per acre, one and one-half bushels on all plats; average yield from small seed, twenty-eight bushels; average yield from large seed, thirty and one-half bushels.

V. EXPERIMENTS WITH DEEP AND SHALLOW PLOWING.

This experiment was commenced in the spring of 1891; range of depth of plowing, four to twelve inches; crop grown, Indian corn; results thus far not decisive. These plats had in previous years all been plowed about eight inches deep. All the plats received a liberal manuring in the spring of 1891.

VI. EXPERIMENTS WITH DEEP AND SHALLOW CULTIVATION OF CORN.

Range of depth: shallow, one to two inches; deep, two and one-half to four inches; time under trial, three years; average yield from deep culture, fifty-four bushels; average yield from shallow culture, fifty-six bushels.

VII. EXPERIMENTS WITH DIFFERENT CORN CULTIVATORS.

Number of implements tested in 1891, five; time under trial, one to three years; three distinct types of cultivator were used, viz.: the common two-horse corn-plow with two shovels in each gang; the spring-tooth cultivator, with five teeth in each gang, and the "gopher" which merely shaves below the surface. Average yield of corn: corn-plow, fifty-six bushels; spring-tooth cultivator, fifty-nine bushels; "gopher" cultivator, sixty bushels.

VIII. CO-OPERATIVE EXPERIMENTS WITH VARIETIES OF WHEAT.

These experiments were begun in the fall of 1890, the purpose is to check the results obtained at the Experiment Station; results will be given in later reports.

IX. CO-OPERATIVE EXPERIMENTS TO DETERMINE EFFECT OF CHANGE OF SOIL AND CLIMATE ON YIELD OF WHEAT.

This work was begun in the fall of 1891 by obtaining seed wheat of one variety grown at Sub-Stations to grow alongside of seed of the same variety produced at the Experiment Station.

X. EXPERIMENTS TO DETERMINE EFFECT OF PREVIOUS MANURING ON YIELD OF CORN.

Gas lime, ammoniated phosphate and fresh horse-manure were applied in 1883 and in 1884 to ground that has been producing corn continuously since 1880 to the present. There has been no fertilization before or since the years named above. The gas lime and phosphate have had practically no effect on yield; average gain per acre from horse-manure, over twelve bushels; gain from horse-manure in 1891, seven bushels; aggregate gain from horse-manure in eight years, nearly one hundred bushels.

XI. EXPERIMENTS WITH ROTATIVE CROPPING AND CONTINUOUS GRAIN GROWING WITHOUT MANURE.

Corn, oats and wheat are grown continuously on series H. The same grains, in connection with beans, roots and grass, are grown in rotation on series F. The entire crop is harvested and removed in every case. The average yields of the staple grains for the last four years are as follows: Series F—corn, thirty-four bushels; oats, thirty-five bushels; wheat, twenty-one bushels. Series H—corn, thirty bushels; oats, twenty-six bushels; wheat, fourteen bushels. Average gain per acre from rotative cropping: corn, four bushels; oats, nine bushels; wheat, seven bushels.

XII. EXPERIMENTS WITH FULL AND TWO-THIRDS APPLICATIONS OF MANURE AND FERTILIZERS.

The purpose of these experiments is to determine (1) the maximum limits of crop production, and (2) the relative economy of heavy and light manuring. Fresh stable manure and high grade commercial goods are used in these trials. Time of trial two years; average gains in bushels per acre of the several grain crops, as follows:

APPLICATIONS.	BARLEY.	CORN.	OATS.	WHEAT.
Full applications of fertilizers...	12.3	6.7	2.5	3 6
Two-thirds " "	9.1	9.1	3.3	7 8
Full applications of manures...	8.2	16.6	11.7	3.3
Two-thirds " "	8.6	15.0	9.4	4.8

XIII. EXPERIMENTS WITH COMPLETE AND PARTIAL FERTILIZERS AND MANURES.

As the results of this work, which was begun only two years ago, are not conclusive as yet, a full statement is reserved for a future report.

Respectfully submitted,

W. C. LATTA,
Agriculturist.

To C. S. PLUMB,
Director.

REPORT OF VETERINARY DEPARTMENT.

My connection with this Station dating only from September last, there is little to report relative to investigation of animal diseases. During the earlier part of my incumbency there was prevalent to a considerable extent in this section the comparatively new and as yet illy understood foot and mouth disease of cattle, and a brief bulletin (newspaper) was issued relating to the treatment of affected animals designed merely to alleviate the most annoying and dangerous symptoms. Experiments were also undertaken with three dairy calves, in which it was attempted to produce the disease by transferring the disease products from the mouth of a seriously affected cow, to the healthy calves, the diseased discharges being violently rubbed into the mouths of the experimental calves. The latter were visited daily for as long a time as seemed at all warrantable, and no signs of the disease were manifested. These results are in full accord with similar experiments conducted by me in Illinois a few weeks earlier.

Experiments have been begun with actinomycosis (lumpy-jaw), but the disease is one of slow development and the work has not yet sufficiently progressed to afford any results worthy of communicating. I expect to continue the study of this disease in relation to its contagiousness and the status of the flesh of affected animals for human food.

I am further watching with great interest a disease developed in two experimental pigs, which is apparently due to the food and environments under which the animals were placed.

Respectfully submitted.

W. L. WILLIAMS,
Veterinarian.

To C. S. PLUMB,
Director.

REPORT OF CHEMICAL DEPARTMENT.

The following is a brief synoptical report of the Chemical Department of the Experiment Station for the year 1891:

Cattle food analyses	23
Manures, special fibre analyses	6
Sugar beet analyses	188
Fertilizers, inspection analyses	7
Preservaline	2
Supposed poisoning, calf	1
Tallow factory refuse	1
Waters	5
Soil	2
Phosphate waste	1
Potash salt	1
Nitrogen in wheat	28
Phosphates	161
Assay for gold and silver	1

Field work has been in progress on sugar beets on the farm and samples of seed were furnished to 70 outside points in the State. Analyses of the beets were made as soon as these stations forwarded the beets raised, The work in this line has been quite an advance over that done in previous years, both in amount and quality.

One set of experiments in the field on the forms of nitrogen for wheat, 63 plats, has been completed and experiments on 105 plats are now in progress.

Field experiments were conducted on phosphates, with especial reference to phosphates containing high percentages of alumina. Experiments are now in progress in the green-house on the same subject.

It is believed that the work done on phosphate of alumina has been of value, inasmuch as it shows not only the difference in chemical behavior between this material and the usual forms of phosphates, but also shows that these differences call for different usage in the application of this material in agriculture, and points out the line of its successful use.

Considerable attention has been given to investigation and improvement of analytical methods used in agricultural analysis. During the year considerable work was done on determination of boracic acid, methods for analysis of cattle foods, and methods of analysis of phosphates. The Chemist was reporter on phosphoric acid and water for the Association of Official Agricultural Chemists during the past year, and the methods developed in the laboratory of the Department were adopted as official methods by that body.

The usual number of specimens of material of various kinds, requiring little chemical work, but a statement of the kind of material, have been received and reported upon.

The Department is called upon frequently for work and information by the other departments of the Station, and considerable time, labor and material are devoted to this part of the work.

The equipment of the Laboratory has been well maintained, and, in addition to the current additions of apparatus, a polariscope, with accessories, a large mill for grinding samples of feeding material, and a special drying apparatus for moisture determinations in feeding material, have been added.

Respectfully submitted,

H. A. HUSTON,
Chemist.

To C. S. PLUMB,
Director.

REPORT OF THE HORTICULTURAL DEPARTMENT.

The following is a synopsis of the work done by the horticulturist for 1891:

FRUITS.

1. *Tests of varieties of orchard fruits*—These remain about the same as given in the last report, with the exception of a few varieties added last year. Owing to severe frosts early in the season, but little fruit was obtained, but the trees have all made a very luxurient growth and appear to be perfectly hardy.

2. *Tests of varieties of small fruits*—This is a continuation of the variety tests in which is recorded the first bloom, first ripe, first picking, length of bearing season, vigor of plant, comparative productiveness, size, quality and firmness of fruit. This included 63 varieties of strawberries, 23 raspberries, 16 blackberries, 9 currants, 4 gooseberries, and 33 grapes.

3. Cross-fertilizing strawberries and producing new varieties from the seeds, some of which are very promising.

4. The improvement of the persimmon and papaw, by selection and cultivation, was commenced.

5. The study was begun this year of the relative value of buds for grafting, as influenced by their position on the branch. This will require some time before results can be obtained.

VEGETABLES.

1. *Tests of varieties of potatoes*—In this experiment 84 different varieties were planted and given the same treatment throughout the season. The special records taken were of bushels per acre of marketable tubers, bushels per acre of small tubers, total yield per acre, and date of ripening.

2. Testing commercial and other fertilizers on potatoes for the purpose of ascertaining whether the soil was deficient in

either nitrogen, phosphoric acid or potash. For this purpose bone-black, nitrate of soda and sulphate of potash were used in different quantities on different plats, and results recorded.

3. Methods of cutting potatoes for planting, also effects of sub-soiling, mulching, level and hill culture, using as fertilizers an equivalent of 160 lbs. of potash, 90 lbs. of phosphoric acid, and 125 lbs. of ammonia per acre. This was thoroughly mixed, and one-half applied broad-cast after the trenches were prepared, and the remainder after the trenches were filled.

Plats 1, 2 and 3 were planted as follows, each plat being divided into three smaller ones:

Plat 1*a* whole tubers, 18 inches apart in the row.

Plat 1*b* whole tubers with seed end removed, same distance.

Plat 1*c* one-half tuber with seed end removed, split lengthwise, cut surface down.

Plat 4, all planted to seed ends. In other respects the same as the others.

The whole of plat 1 received about one inch of mulch after the tubers had been partially covered with soil, after which the trenches were filled with soil.

In plat 2 the trenches were only partially filled with soil at the time of planting, but gradually filled with the cultivator to the general level.

Plat 3 was filled level full at the time of planting. In other respects like plat 2.

Plat 4 was only partially filled at the time of planting and filled in later.

All plats were given level culture till July 10th, when each alternate row was hilled up.

4. The following conclusions may be expressed: First, sub-soiling gave a very small increase in yield over ordinary plowing. Second, the mulch was injurious rather than beneficial. Third, ridge culture gave a small increase over level. Fourth, half tubers gave a larger yield than whole ones. Fifth, seed ends gave a much larger proportion of large tubers. Sixth, trenches filled only half full at time of planting, gave a larger yield than those filled full.

5. Testing 40 varieties of sugar corn, obtained from different sources and given like conditions. The per cent. germinating, date of blossoming, date of edibility, quality and comparative yield were noted.

6. Improving quality of certain varieties of corn by cross-fertilization.

7. Tests of 35 varieties of garden peas, all obtained from one source. Same notes as No. 5.

8. Tests of 30 varieties of Wax beans obtained from different sources. Various synonyms discovered.

9. Tests of tomato seed from early and late ripening fruits. Also number of times best to transplant before finally planting out in the open field.

INSECTICIDES.

1. The following tests were made with insecticides on potatoes for the Colorado potato beetle (*Doryphora 10-lineata*). The plat was divided into two parts, on one of which the materials were used in the dry state (except the arsenite of ammonia), and on the other in solution. Each half-plat was divided into five smaller parts, on which were used respectively, slug-shot, pyrethrum, hellebore, arsenite of ammonia and London purple. Two applications were made. Arsenite of ammonia gave best results; London purple, when in solution, next best; pyrethrum soon lost its virtue; slug-shot and hellebore gave the poorest results when applied in solution, but showed a marked improvement when in the dry form.

2. A solution of nitrate of soda was used on the potato beetle, and also on the striped beetle (*Diabrotica vittata*) on squash and melon vines, but with unsatisfactory results.

3. Solutions of whale oil soap and kerosene emulsion were used on plum, cherry and maple trees for the aphides and *Pulvinaria innumerabilis* with very satisfactory results.

4. Hot water at a temperature of 135 degrees was also used on several plants for the aphides, with good results.

FUNGICIDES.

1. Several applications of the Bordeaux mixture were made for the Black Rot of grapes, but owing to heavy frosts in May, but very little fruit was left to mature, so that, while those clusters which escaped frost showed beneficial results, it would be difficult to state just what per cent. of the crop was saved by this remedy.

2. A test of potassium sulphide was made on two varieties of foreign grapes in a neighboring hot-house as a remedy for the Powdery Mildew, with the result of saving a large portion of the crop.

Besides the foregoing, a large number of tests have been made with both fruits and vegetables, by the ten sub-stations located in different portions of the State, reports from which have been received and recorded. The number of sub-stations has recently been reduced to four, which are located in Lagrange, Marion, Clay and Floyd Counties.

Respectfully submitted,

JAMES TROOP,
Horticulturist.

To C. S. PLUMB,
Director.

REPORT OF THE BOTANICAL DEPARTMENT.

A large amount of work has been carried on in the Botanical Department of the Station during the year 1891, chiefly of a physiological and pathological nature. The economic value of some of the conclusions arrived at is of more than usual importance, while nearly all of the work has well repaid the labor and thought expended upon it. In attempting to secure information that may be readily applied by the cultivator to increase the profits of his business, the opportunity has not been lost to investigate a number of problems of scientific moment which underlie the more obvious economic questions, and serve to place the latter upon a much firmer basis.

CORN.

The experiment conducted in 1889 and set forth in the Annual Report for 1890 upon the relation of the weight of the kernel to the after-growth and yield, was repeated during the year. The results fully confirm the previous conclusions, and show that the larger kernels produce a stronger growth and heavier yield. As the kernels on an ear are heaviest at the butt and decrease in weight toward the tip, the butt kernels are the most valuable for planting, and the kernels on the remainder of the ear are somewhat less valuable in proportion as they are situated farther from the butt.

The high efficiency of the hot water treatment of the seed of wheat and oats in preventing smut in those cereals, suggested the trial of the same means of removing smut from corn. Corn smut is very prevalent and causes much injury to the crop in this State, and it being a leading farm product, a preventive for the smut is highly desirable. The hot water treatment carried out essentially as for oats and wheat, was

tested on rather a large scale, two fields at some distance apart being used. Quite contrary to what was anticipated, the result showed no diminution in the amount of smut that could be ascribed to the treatment. The range of temperature was extended to the limits of the vitality of the seed corn, and we are therefore forced to acknowledge that there is no prospect that the hot water treatment will be found serviceable in preventing corn smut.

In order to learn whether the smut of corn comes from planting infected seed or not, an attempt was made to artificially infect the plant by applying a large amount of smut powder to the seed at the time of planting. With oats and wheat this is a very efficient method to increase the percentage of smut in the crop. The smut was applied to the kernels of corn moistened with flour paste in order to make it adhere well. The results gave no indication that the plants had received infection from this source, in fact the rows in which kernels were coated with smut showed scarcely as much smut in the plants as the rows which received no application.

OATS.

The hot water treatment for the prevention of smut in oats has been further tested, and the favorable conclusions of previous years confirmed. A bulletin (No. 35), embracing a large amount of data, and giving the mode of procedure in the practical application of the method in farm practice, was issued in March, 1891. The use of this means of ridding oats of smut must result in preventing a heavy loss to the farming community. It has already been adopted by many farmers of the State, and there is indication that its use will soon become general.

A fact, which first came out incidentally during the treatment for smut, but which has since assumed most important proportions, is the gain in yield which oats (and also wheat). show, entirely due to the warm bath given the grain before sowing. This increased yield, believed to amount to at least ten per cent., averaging one season with another, has led the Department to recommend this method as a profitable one for increasing the yield of oats.

WHEAT.

The hot water method has been applied to the prevention of stinking or hard smut of wheat with complete success. The temperature of the water, and other details of treatment, were given in Bulletin No. 32 (1890), but at that time the efficiency in preventing the smut had not been fully demonstrated. During 1891 the results obtained from field experiments have left no doubt that the method is thoroughly satisfactory, and with only ordinary care is capable of preventing all appearance of smut in the crop.

The above remarks refer to stinking smut only. Loose smut of wheat, which closely resembles the common smut of oats, and which was very abundant this last year, 1891, throughout the State, attracting general attention about the time wheat was in flower, reacts very differently toward the hot water treatment from what stinking smut does. The closing sentence of Bulletin No. 32 (July, 1890), reads as follows: "The prevention of loose smut of wheat has not been made the subject of experiment, but it is presumable that the treatment (with hot water), recommended above for stinking smut will be found satisfactory." The data from field tests for the present year, however, do not at all bear out this assumption. In fact, the trials in which the seeds were immersed in water at 135° F., for five minutes, show that the treatment has no effect whatever in reducing the percentage of loose smut. We are consequently forced to admit that while the hot water treatment is highly satisfactory in eradicating stinking smut, it is of no service against loose smut.

An important fungous injury to wheat in the field, known as *scab*, was detected in the fields of the Station and elsewhere in the State during the last season. It affects the heads and shows most prominently just before ripening sets in. The loss amounted to fifteen per cent. of the crop in some fields. The matter has been made the subject of a bulletin article (No. 36, August, 1891), and will also receive further attention.

The use of seed grain having various degrees of maturity was tested in a preliminary experiment, but the results are not sufficiently complete to hazard any general conclusion.

POTATOES.

The work with potatoes has received more attention than has been given in any other direction, and the results have been of great interest and importance. Many of the experiments performed in 1890 have been repeated during the last year, and others added. Some of the results have been embodied in a paper entitled "A Physiological Basis for the Comparison of Potato Production," read before the Society for the Promotion of Agricultural Science, and published in the proceedings for 1891. The remainder and larger part of the data has not yet been placed before the public.

Some of the conclusions of this work are that the larger the potatoes, or pieces of potatoes, that are planted, the larger the yield; that the seed (apical) end of the tuber gives the strongest shoots and is the best part of the tuber for planting; that rough potatoes contain more starch and are better for planting than smooth potatoes of the same variety; that the number of eyes on a piece bears no important relation to the yield, care should, therefore, be exercised as to the size of the piece planted, rather than to the number of eyes; that cut tubers are better than whole ones, because they take up water from the soil more readily and permit more rapid growth; and that the seed material will be improved by drying somewhat before planting, provided the loss in weight does not exceed 20 per cent. Other important results have been secured which can not well be presented in the brief space at command in this outline.

The scab organism, discovered by Dr. Thaxter in Connecticut, has been detected during the year, and is believed to be common in this State and an efficient cause of more or less of the scab of potatoes, especially in its worst form. The organism has been, and is still, under cultivation in the laboratory.

BEETS.

Very considerable attention has been given to the diseases of sugar beets. This work has been principally carried on by Miss Katherine E. Golden, who read a paper upon the subject in December last before the Indiana Academy of Sciences.

The beet root is subject to scabbing, caused by the same organism that is mentioned above as being found upon potatoes.

It does not, however, appear to seriously affect the value of the roots for the purposes for which they are ordinarily grown. Some still less important ailments of the roots have been noted and examined.

From an economic standpoint, far the most important affection of the beet root is one that decreases the sugar content from a few per cent. down to 50 or even 75 per cent. below the normal. The disease is found to be quite wide spread, and holds a place of no inconsiderable importance in relation to profitable sugar beet industry. The disease is of bacterial nature, the microbes being found in great numbers in all affected beets. The organisms occur in all parts of the beet root, but the changes which they occasion do not alter the appearance of the tissues materially, although a person having the necessary experience may be able to detect the presence of the disease with much certainty upon cutting the root open. Much study has been given to the characteristics and development of this micro-organism, and the results will be published early in 1892.

TOMATOES.

The relation of immaturity of seed to earliness in ripening of the fruit continues to receive attention, the problem having been studied from new points of view during the last year. Although much study and labor have been devoted to the subject, yet no full and satisfactory conclusion has been arrived at, and the investigation will be carried over into the coming year.

Some attention has been given to several matters of heredity, looking toward a better understanding of the conditions underlying the improvement of this fruit, and similar cultivated plants Among the most interesting facts elicited is the distribution of a certain range in number of seed cavities in the fruit among the fruits of a single plant, and also among the fruits of a variety. The data has not received adequate study at this writing, however, to warrant a statement of the full bearing of the discoveries

CARNATIONS.

In the middle of October some leaves of carnation pinks were received from Indianapolis affected with a destructive

fungus. The fungus was at once recognized as a species of rust, long known in Europe, but never before reported in this country. Personal visits were made to several places in the State where the business of raising carnation pinks is carried on upon a large scale, and it was found that the disease, although not yet general, is one that seriously threatens the industry. It is believed, however, that a remedy can be devised to keep it in check, and possibly means can be found for thoroughly eradicating it. Experiments looking toward these ends are now being carried out in the greenhouse.

Many minor inquiries have received attention during the year which need not be mentioned here.

Respectfully submitted,

J. C. ARTHUR,
Botanist.

To C. S. PLUMB,
Director.

The Agricultural Experiment Station of Indiana in Account With the United States for the Year Ending June 30, 1891.

Debit—		
Appropriation		$15,000
Credit—		
Supplies	$1,403 43	
Apparatus	250 51	
Repairs	72 05	
Improvements	44 00	
Printing, stationery and bulletins	881 16	
Books	118 16	
Care of buildings	337 00	
Salary	6,094 90	
Assistants	626 86	
Labor	3,728 00	
Postage	51 09	
Insurance	30 00	
Express, freight and hauling	166 23	
Miscellaneous	21 50	
Stock	1,028 51	
Gas	69 43	
Telegrams	1 64	
Traveling expenses	28 73	
Advertising	46 80	
Total		$15,000

The above is a correct statement of the general fund of the Agricultural Experiment Station of Indiana for the year end-June 30, 1891.

E. A. ELLSWORTH,
Secretary Board of Trustees.

Improvement Fund Experiment Farm for Year Ending June 30, 1891.

DEBIT—		
Balance unexpended June 30, 1890 ...	$413 02	
Receipts from sale of farm products....	2,311 03	
CREDIT—		$2,724 05
Repairs	34 48	
Printing and stationery	20 00	
Labor	365 51	
Books and periodicals....	351 53	
Advertising	13 80	
Improvements	12 25	
Traveling expenses	12 20	
Express and freight....	23 16	
Employes	123 33	
Salary	678 24	
Supplies	359 52	
Balance unexpended	730 03	
Total		$2,724 05

The above is a correct statement of the improvement fund for year ending June 30, 1891.

E. A. ELLSWORTH,
Secretary Board of Trustees.

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING
1898.

PURDUE UNIVERSITY.

FIFTH ANNUAL REPORT

OF THE

Agricultural Experiment Station,

LAFAYETTE, INDIANA.

1892

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.
1893.

THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT.
INDIANAPOLIS, Jan. 31, 1893.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

FEBRUARY 3, 1893.

Returned by the Auditor of State, with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

MYRON D. KING,
Private Secretary.

Filed in the office of the Secretary of State of the State of Indiana, February 3, 1893.

W. R. MYERS,
Secretary of State.

Received the within report and delivered to the printer February 3, 1893.

CHRIS. H. STEIN,
Clerk Printing Bureau.

BOARD OF CONTROL.

CHARLES B. STUART, PRESIDENT	LaFayette.
William A. Banks	LaPorte.
Jasper N. Davidson	Whitesville.
Ulric Z. Wiley*	Fowler.
Sylvester Johnson	Irvington.
David E. Beem	Spencer.
Jasper M. Dresser	LaFayette.

JAMES H. SMART, LL. D.,
President of the University.
EDWARD A. ELLSWORTH, *Secretary.*
JAMES M. FOWLER, *Treasurer.*

STATION STAFF.

Charles S. Plumb, B. S	Director.
William C. Latta, M. S	Agriculturist.
James Troop, M. S	Horticulturist.
Henry A. Huston, A. M., A. C	Chemist.
Joseph C. Arthur, D. Sc	Botanist.
W. L. Williams, V. S	Veterinarian.
Arthur Goss, B. S., A. C.*	Assistant Chemist.
Katherine E. Golden, M. S	Assistant Botanist.
W. Fred McBride, B. S	Assistant Chemist.

* Resigned in middle of year.

To the Governor:

I herewith transmit the Annual Report of the Purdue University Agricultural Experiment Station, due February 1, 1893.

Very respectfully,

C. B. STUART,

JANUARY 30, 1893. *President Board of Trustees.*

To the President of the Board of Trustees:

I herewith present the Annual Report of the Agricultural Experiment Station of Indiana, due on or before the first of February, 1893, the same being required by section 3 of an act entitled "An act to establish agricultural experiment stations in connection with the colleges established in the several States, under provisions of an act approved July 2, 1862, and of the acts supplementary thereto."

This report consists of a report of the Director of the Station, and the financial report of the Secretary to the Board of Trustees.

Respectfully submitted,

J. H. SMART,

President.

Purdue University, Lafayette, Ind., January 30, 1893.

FIFTH ANNUAL REPORT

OF THE

Purdue University Agricultural Experiment Station.

REPORT OF THE DIRECTOR.

To President James H. Smart:

SIR—I have the honor to herewith transmit to you the Fifth Annual Report of the Purdue University Agricultural Experiment Station, for the year 1892.

The Station Staff has undergone no change of sufficient importance to affect the administration of department work. Mr. Arthur Goss, who acceptably acted as Assistant Chemist for some years, resigned his situation on July 1, to accept the chair of Chemistry at the New Mexico Agricultural College, and become Chemist of the Experiment Station connected with the College, and Mr. W. F. McBride, a graduate of Purdue University, was appointed his successor.

The Investigations in progress during the year were mainly a continuation of those well in hand during 1891, and it is proposed to still further concentrate attention upon these, as promising results of significance.

The study of the sugar beet in the Chemical and Botanical Departments has been considerably extended, and while the growing season this year was generally unsatisfactory over the State, owing to excessive moisture during planting time,

and drought later on, the work warrants an industrious continuation. During 1891, sugar beets were grown under instruction from the station from seed furnished by it, in ninety different localities over the State, while during 1892 seed was distributed to 250 points and the interest in the work among farmers greatly increased.

On some farms in the State are found limited areas of soil that refuse to grow perfect crops and such is commonly known as "bogus soil." So many complaints have come to us from farmers concerning such soils that the work of investigating them was actively taken up in the field during this year. Under the supervision of the Chemical Department, such soils on two farms in the State have been studied and crops grown upon them. The results secured from the investigations conducted are of such interest that they will be published in bulletin form early in 1893. This line of research will be continued.

In the Botanical Department the study of the potato, in relation to the number of eyes on the seed tuber to the product, has received much increased attention during the year and the main facts of the work published in Bulletin 42. It is important here to note that while many experiments have been undertaken in various places, bearing upon the cutting of potatoes for seed, this station is the first to publish results and give explanations for the same, based on the physiological structure of the tuber.

Experimental work in the dairy has been taken up for the first time this year. Experiments on the aeration of milk, and upon methods of setting milk, have occupied considerable attention. In view of the growing importance of Indiana as a dairy State, I believe that it will be well for the Station to take an active part in this development, therefore it would seem advisable to employ an assistant, who should conduct experimental work in the dairy, and give instructions to students of the University in dairy husbandry. Such an assistant would enable the Station to accomplish important experimental work not now feasible.

In the Agricultural and Horticultural Departments no essentially new lines of work have been successfully prosecuted during the year, climatic conditions having caused practical failure in some of the work attempted.

On the farm, feeding experiments have been in progress with steers, calves and pigs, dealing with the same subjects noted in the last report of this Station.

The Publications of the Station during the year have been limited to one one-page newspaper and five extensive bulletins, viz.:

Newspaper Bulletin No. 3, March 25, 1892. Tests of varieties of Oats, by W. C. Latta, Agriculturist.

Bulletin No. 38, vol. III, March, 1892, pp. 1–32, plate I. (1) Small Fruits. (2) Treatment of Powdery Mildew and Black Rot. (3) Vegetables, by James Troop, Horticulturist.

Bulletin No. 39, vol. III, April, 1892, pp. 33–62, plates II, III. (1) Field Experiments with Corn, by W. C. Latta, Agriculturist. (2) Sugar Beets, by H. A. Huston, Chemist. (3) Diseases of the Sugar Beet Root, by J. C. Arthur, Botanist, and Katherine E. Golden, Assistant Botanist.

Bulletin No. 40, vol. III, June, 1892, pp. 63–81, fig. 1. The Silo and Silage in Indiana, by C. S. Plumb, Director.

Bulletin No. 41, vol. III, August, 1892, pp. 83–102. (1) Field Experiments with Wheat, by W. C. Latta, Agriculturist. (2) Forms of Nitrogen for Wheat, by H. A. Huston, Chemist.

Bulletin No. 42, vol. III, November, 1892, pp. 105–118. The Potato; the Relation of Number of Eyes on the Seed Tuber to the Product, by J. C. Arthur, Botanist.

The above bulletins have dealt almost entirely with the original investigations conducted at the station, excepting for a portion of bulletin 40, and may be considered direct contributions to a knowledge of science as applied to agriculture. These publications have been widely distributed over the State. On January 1, 1892, the station mailing list consisted of 5,800 addresses, and these had increased up to January 18, 1893, to 7,650. I wish to call special attention to the fact that this list is a growth almost entirely the result of personal application to the station and its officers, so that it is fair to assume that it is of the most desirable kind. The expense of printing many thousands of these documents is considerable, and is borne by the station. If this work could be done by the State Printer, at State expense, as is done for numerous stations outside of Indiana, it would be a great saving of funds to be applied in other important directions. The State of Ohio prints for the Experiment Station 60,000 copies of each bulletin, free of expense to the station.

Acknowledgments are here gratefully made to the following parties for gifts to the Station, as indicated:

F. A. Tripp, Chicago, Ill., five sacks (224 pounds each) dairy salt.

Mortimer Levering, Secretary, LaFayette, Ind., Vols. 6 and 7 American Shropshire Sheep Record.

United States Department of Agriculture, Washington, D. C., seeds and publications from the several divisions of Department.

Moses J. Miller, Shipshewana, Ind., one old sickle.

Joseph Harris Seed Company, Moreton Farm, N. Y., four packets tomato seed.

Poindexter Manufacturing Company, Indianapolis, Ind., corn splitting machine.

Lewis Roesch, Fredonia, N. Y., two gooseberry plants.

I. N. Shannon, Goodlettsville, Tenn., one quart corn.

L. D. Brown, Elkhart, Ind., bag soja beans.

J. T. Groves, Dana, Ind., seven ears sterling corn.

C. P. Bauer & Co., Judsonia, Ark., dozen West Lawn strawberry plants.

S. W. Dungan, Franklin, Ind., one quart seed corn.

H. H. Clark, Onarga, Ill., sack seed corn.

W. T. Branson, Ipava, Ill., sack seed corn.

Riley Sanders, Bloomington, Ind., sack seed corn.

M. Pfile, Freeport, Ill., sack seed corn.

K. B. Moorhous, Boone, Iowa., sack seed corn.

C. E. Angell & Co., Oshkosh, Wis., three varieties seed corn, and seedling potatoes Nos. 27 and 101.

Mark W. Johnson Seed Company, Atlanta, Ga., one packet beans.

J. A. Lintner, New York State Entomologist, Albany, N. Y., 1st, 2d, 4th, 5th, 6th, 7th Annual Reports New York State Entomologist. Bulletins 5 and 6 New York State Museum of Natural History.

W. W. Waldron, LaFayette, Ind., first thirteen volumes Herd Register American Jersey Cattle Club.

Fletcher, Hard & Roberts, Kentland, Ind., one Gopher cultivator.

F. W. Taylor, Secretary, Lincoln, Neb., Annual Report of Nebraska State Horticultural Society for years 1885, 1886, 1889, 1890, 1891, 1892.

Polar Creamery Company, LaFayette, Ind., one Polar Creamery complete, and thermometer.

E. G. Hill & Co., Richmond, Ind., 150 rose plants and four plants of "Star of '91" canna.

Berterman Bros., Indianapolis, Ind., twenty-four carnation plants.

Fred. Dorner & Son, Lafayette, Ind., seventy-two carnation plants.

W. M. Wiley, Secretary, New Augusta, Ind., Vol. I, Improved Essex Swine Record.

Jonathan Thorn, Secretary, Black Rock, Conn., Reports of New York Farmers.

L. J. Noe, Winamac, Ind., weed slayer.

F. C. Boucher & Co., St. Paul, Minn., 5 lbs. par-oidium or black sulphur.

W. R. Hostetter, Secretary, Mt. Carroll, Ill., Reports Illinois State Dairymen's Association for 1887, 1889, 1890.

Economist Plow Company, South Bend, Ind., Solid Comfort 2-gang plow.

New York Agricultural Experiment Station, Peter Collier, Director, Geneva, 2 graphic charts.

C. M. Winslow, Secretary, Brandon, Vt., Vols. IV, V, VI, VII, VIII, Ayrshire Breeders' Association.

D. Y. Hallock, York, Pa., 1 Success Potato Digger.

F. C. Huntington & Co., Indianapolis, Ind., one-half peck of early ripe seed wheat.

Mrs. Kate M. Busick, Wabash, Ind., Jersey bull calf, "Purdue Boy" 31287, A. J. C. C.

S. W. Smith, Cochranville, Pa., 4 lbs. seed wheat.

James Riley, Thorntown, Ind., 6 varieties seed wheat.

John Brand, Mulberry, Ind., 6½ lbs. seed wheat.

A. N. Jones, LeRoy, N. Y., bag Stock Fife wheat and packet Early Genesee Giant wheat.

Farmer Seed Company, Chicago, Ill., sack seed wheat.

John O. Davis, Goodhue, Minn., one Perfection cow tie.

Sherman, Hall & Company, Chicago, Ill., forty samples of wool, showing Chicago market classification.

Storrs, Harrison & Co., Painesville, O., currant plant.

John Gordon, Secretary, Mercer, Pa., Volume I, Hampshire Down Flock Record.

J. McLain Smith, Secretary, Dayton, O., volumes I–IV, American Red Poll Herd Book.

The following periodicals have been sent gratuitously to the Station, for which thanks are due to the publishers:

American Agriculturist	New York City.
American Bee Journal	Chicago, Ill.
American Grange Bulletin	Cincinnati, O.
American Rural Home	Rochester, N. Y.
American Sheep Breeder and Wool Grower	Chicago, Ill.
American Swineherd	Chicago, Ill.
Baltimore Sun (weekly)	Baltimore, Md.
Breeders' Gazette	Chicago, Ill.
Dairy Column	Chicago, Ill.
Dairy Messenger	Chicago, Ill.
Drainage Journal	Indianapolis, Ind.
Elgin Dairy Report	Elgin, Ill.
Experiment Station Record	Washington, D. C.
Farm and Fireside	Springfield, O.
Farm and Home	Chicago, Ill.
Farm, Field and Fireside	Chicago, Ill.
Farm Journal	Philadelphia, Pa.
Farmers' Advocate	London, Ont.
Farmers' Call	Quincy, Ill.
Farmers' Home	Dayton, O.
Farmers' Journal	Hornellsville, N.Y.
Farmers' Record	Muncie, Ind.
Farmers' Review	Chicago, Ill.
Good Roads	New York City.
Grange Visitor	Lansing, Mich.
Hoard's Dairyman	Ft. Atkinson, Wis.
Holstein-Friesian Register	Boston, Mass.
Home and Farm	Louisville, Ky.

Hospodar	Omaha, Neb.
The Husbandman	Binghamton, N. Y.
Indiana Farmer	Indianapolis, Ind.
Industrial American	Lexington, Ky.
Industrialist.	Manhattan, Kan.
Insect Life	Washington, D. C.
Jersey Bulletin.	Indianapolis, Ind.
Journal of Agriculture	St. Louis, Mo.
Journal of Mycology	Washington, D. C.
Kansas City Live Stock Indicator	Kansas City, Mo.
Kansas Farmer	Topeka, Kan.
Louisiana Planter	New Orleans, La.
Maritime Agriculturist	St. John's, N. B.
Mennonitische Rundschau	Elkhart, Ind.
Michigan Farmer	Detroit, Mich.
Milling	Indianapolis, Ind.
Mirror and Farmer.	Manchester, N. H.
National Stockman and Farmer	Pittsburgh, Pa.
Nebraska Bee-Keeper.	York, Neb.
Nebraska Farmer	Lincoln, Neb.
New Dairy, The	New York City.
New England Farmer	Boston, Mass.
Ohio Farmer.	Cleveland, O.
Orange Judd Farmer	Chicago, Ill.
Pacific Rural Press.	San Francisco, Cal.
Practical Farmer.	Philadelphia, Pa.
Rural Home.	Philadelphia, Pa.
Rural Northwest.	Portland, Ore.
Southern Cultivator and Dixie Farmer.	Atlanta, Ga.
Sugar Beet.	Philadelphia, Pa.
Wayne Farmer.	Hagerstown, Ind.
Western Plowman	Moline, Ill.
Western Swineherd.	Geneseo, Ill.
Wisconsin Agriculturist.	Racine, Wis.
Wisconsin Farmer	Madison, Wis.

I herewith append the reports of the several departments of the Station, briefly outlining the work of the year, to which I respectfully call attention.

Respectfully submitted,

C. S. PLUMB,
Director.

REPORT OF VETERINARY DEPARTMENT.

To C. S. Plumb, Director:

In submitting my report as Veterinarian to the Experiment Station for 1892 I have to say that no experimental work of any special value, in so far as results are concerned, has been carried out.

Early in the year an experiment was undertaken with contagious pleuro-pneumonia of horses, which through lack of material proved a failure, none of the experimental animals having contracted the disease.

During the summer vacation I made tests as to the poisonous effects of the leaves of the coffee-nut tree, which were reported to be causing occasional deaths among sheep, but which, it appears by my experiments (a report of which has been handed you) is entirely without foundation.

I also had occasion to investigate an outbreak of verminous disease among lambs due to the *Strongylus contortus*, in which it was demonstrated that turpentine, which is generally recommended for this disease, is quite ineffectual, while santonine apparently did some good, but the opportunities for thoroughly testing the latter were not sufficient to permit a reliable conclusion.

Respectfully submitted,

W. L. WILLIAMS,
Veterinarian.

REPORT OF THE CHEMICAL DEPARTMENT.

To C. S. Plumb, Director:

The following is a condensed statement of the work of the Chemical Department for the year 1892:

Work upon the raising of sugar beets in Indiana has been continued, and the number of stations considerably enlarged. In 1891 seed was sent to ninety stations, and in 1892, to 250 stations. Every county in the State had one or more stations located in it. The spring was extremely unfavorable for planting beet seed, and the delays due to unfavorable weather in many cases prevented the seed being planted at all, and in others

the heavy rains prevented the sprouting of the seed. However, samples were received from over forty of the stations, and the results were as good, if not better, than those of the preceding year.

The work on forms of nitrogen for wheat has been continued and the results have already appeared in bulletin form. In general, these results confirm those of preceding years.

Field work upon phosphates has also been continued with special reference to the presence of aluminium in phosphates. This work is of special interest now, owing to the discovery of large amounts of phosphate in Florida, which phosphate in many cases contains unusually large quantities of aluminium. Laboratory work has been in progress on the phosphates with a view of determining the origin of the phosphoric acid found in super-phosphates.

The investigation of the so-called bogus soils has been taken up, and work in both field and laboratory has been conducted. The field work has given unusually promising results, and the present indications are that comparatively little can be learned in regard to these soils in the laboratory until after a very careful survey of the character of the land and its drainage.

In connection with this work upon soils, an investigation of the methods for determining the humus in soils has been taken up and is now in progress.

The occurrence of large bodies of so-called bogus land in all sections of the State seems to indicate that an investigation of such tracts is one which is well worthy of the attention of the station. The general character of the lands is such that when properly treated they become among the most fertile of our lands.

Many examinations of the acidity of milk were made during the summer for the Dairy Department.

The usual amount of current work for other departments, the examination of feeding stuffs, and the usual amount of examinations of miscellaneous material sent to the Station have been carried on. The addition of an Assistant Chemist who should devote his entire time to the chemical work of the Station has enabled the Department to do more laboratory work than formerly, but the policy has been to improve the quality of the work rather than to increase the quantity, and to limit

the investigations to fewer subjects, but go into them more fully.

The equipment of the laboratory during the year has been fully maintained. Respectfully submitted,

H. A. HUSTON,
Chemist.

REPORT OF THE HORTICULTURAL DEPARTMENT.

To C. S. Plumb, Director:

The work in this Department during the past year has included experiments in both fruit and vegetable culture, and also with different insecticides and fungicides. The excessive amount of rainfall during the early part of the season interfered somewhat with certain lines of work, but the results, as a whole, were quite satisfactory.

The experiments in fruit culture, which have been in progress for a number of years, will require some time yet before any definite results can be obtained, especially with orchard fruits. The greater portion of these varieties set out in the spring of 1886 were from the Russian importations sent out by Prof. J. L. Budd, of Iowa, and, notwithstanding the general scarcity of fruit the past season, some of the varieties bore a limited quantity of fruit and the indications are that some of these will prove of much value to the fruit interests of the State.

Owing to the unfavorable conditions—the continued rains, which prevented fertilization and also allowed the insects to work unmolested—there were no pears or cherries and only a very few plums. Grapes and all kinds of small fruits, however, bore abundantly. The following species of native grapes were set last spring for the purpose of crossing with other species and varieties, viz.: *Vitis rotundifolia*, *V. æstivalis*, *V. Monticola*, *V. Borquiniana*, *V. vulpina*, *V. Lincicumii*, *V. Munsoniana*, *V. Berlandieri*, *V. Arizonica*, *V. candicans*, V. *cenera.*

FUNGICIDES AND INSECTICIDES.

Owing to the unfavorable conditions already mentioned, it was impossible to secure any definite results from the application of either the above remedies. Consequently the plum

rot developed to an alarming extent and came near ruining the whole crop. The black rot of grapes began to develop quite early, but by a persistent application of the Bordeaux Mixture, with Paris green added, a portion of the crop was saved.

VARIETAL TESTS OF VEGETABLES.

This included trials of one hundred and twenty varieties of potatoes, thirty-five varieties of peas, forty varieties of beans and sixty-five varieties of tomatoes. Other experiments consisted of testing the effect of detasseling sweet corn on the yield; influence of the seed of the tomato, resulting from grafting it on the potato; seedling tomatoes *vs.* cuttings.

HORTICULTURAL SUB-STATIONS.

These are four in number and are located in the north, north-central, south-central and southern fruit districts of the State. They are each in charge of a practical fruit-grower whose annual report is made to this Station. Following is a brief summary of the reports:

From J. N. Latta, LaGrange County. "This year has been the nearest to a failure for apples that we have ever known, owing to the wet spring. No insecticides were used, as it was impossible to find a day when they could be applied with profit. Rot was very destructive to English plums and somewhat so to grapes. The growth of all kinds of trees and plants was all that could be desired. Every kind of fruit tree blossomed abundantly, but the rain prevented perfect fertilization. Peaches and pears, however, bore well. Alexander is our best hardy peach. Sapieganky pear bore very full. It is a very pretty small pear, and, if picked at the proper time, is of very good quality. Mt. Vernon is the most beautiful of all pears, and an early bearer of most delicious fruit. All small fruits did well. Haverland is the best all around strawberry. All raspberries and blackberries might be improved, as all varieties have some weakness which might be eliminated by breeding."

From Sylvester Johnson, Marion County. "In this locality, the apple crop was very nearly an entire failure. On fifty bearing trees I did not have one-half bushel of apples. There

was an average crop of peaches, pears, raspberries, blackberries and grapes, the last being the most abundant crop and the largest in size but the best in quality that I ever grew We got no cherries; not enough for the robins, which had the first pull at them. Of the grapes, the Agawam and Niagara gave the best satisfaction at the table. The Champion and Martha were most disappointing. I experimented with sugar corn by removing the tassel from alternate hills, but could not discover any difference in yield or quality.

"The only troublesome insects were the currant worm and striped cucumber beetle. The former I got rid of by the use of white hellebore, but the latter bravely met and conquered all of the many insecticides used. The square box with wire netting over the top was the only effectual remedy. I used fungicides and insecticides on my grapes and pears, but the frequent and copious rains so soon followed these applications that the tests were not, I think, beneficial. The most satisfactory experiment I tried was the heavy manuring of my grape vines to prevent rot. This was the second experiment of the kind during the last five years, both times with the same results, to-wit: An abundant crop of fine fruit and little or no rot. My neighbors' grapes, not so manured, rotted badly the same season."

From J. T. Moss & Sons, Clay County: "This has been a very poor season for orchard fruits, and apples, cherries and peaches might be counted a total failure. The leaf blight appeared very bad on the apple trees through this section, and, if it continues, its attacks must end our orchards. All varieties of pears were attacked by blight this season on our grounds except the Kieffer, which held its foliage until very late. The Bessemianka set very full, but cast its fruit before ripening. The Duchess has always borne full crops and has been our standard. We now look to the Kieffer, as Duchess dies badly from blight.

"In plums the Wild Goose alone bore full crops. The Roser peach ripened some fruit, but rot affected the larger portion. As a bearer it is worthy of trial. As a market variety the Downing gooseberry will scarcely have a superior. Fay's currant fruited with us and we found them equal to the best things we ever read about them. Crandall and Lee's bore

very full, but we can not use the fruit; a taste might be cultivated to tolerate the Crandall. For a black currant it is the best we have ever seen.

"A light crop of all kinds of raspberries; the Anthracnose is telling severely on all black caps. A few years more and the industry on any extended system must be abandoned.

"Average crop of blackberry; the Snyder is the only variety fruited here.

"All late blossoms of strawberries blasted on account of wet weather, hence a short crop and high prices."

From Jonathan Beard, Floyd County. "The apple crop was one of the poorest for this locality. Ben Davis and Jonathan were about all that we had, and these were of very poor quality. Peaches, pears and plums were about one-third of an average crop except the new plum, Burbank's seedling. I fruited it this year for the first. It was a lovely sight to see such a heavy crop of large beautiful fruit on so young a tree, only four years old. I picked about three pecks of plums from it. The fruit is large, some specimens having more the appearance of fair-sized peaches than plums.

"The crop of grapes was a fair average one, and the quality good. I sold 1,600 8-pound baskets this season from one acre of 4-year-old vines. The early varieties are the most profitable here.

"STRAWBERRIES AND RASPBERRIES. These crops were a fair average. Some of the new varieties of strawberries, which are highly prized here, are the Bubach and Warfield. The most profitable black raspberry grown here is the old Miami. The best early variety is the Souhegan. The most profitable reds are the Cuthbert and Turner.

"INSECT RAVAGES. Old strawberry beds were almost entirely destroyed the past summer by the crown borer and other foliage eating insects. Codling moths and curculio got in their work pretty effectually on the apple, peach and plum. Spraying did but little good on account of the frequent rains that we had when the work was done."

Respectfully submitted,

J. TROOP,

Horticulturist.

REPORT OF THE BOTANICAL DEPARTMENT.

To C. S. Plumb, Director:

The general plan of work in the Botanical Department has been continued in practically the same lines during 1892 as carried out in previous years. New facts have been brought to light regarding some destructive plant diseases, and remedies have been devised and tested, which in some cases have proven highly satisfactory. Besides the study of diseases and their remedies, which has occupied the larger part of the time of the Department, attention has also been directed, as heretofore, toward the solution of certain physiological problems, which underlie important cultural operations.

OATS.—The results obtained this year in preventing smut and increasing the yield by treating seed oats to a hot water bath have confirmed the previous work in this line, and leave no possibility of doubt regarding the great practical utility of the process.

Seed saved from a field of oats, which contained 37 per cent. of smut in 1891, gave 27.6 per cent. of smut in 1892. The same seed treated with hot water at various temperatures from 130° to 140° F., for 5 minutes gave only 1.3 per cent. on an average, part being entirely free from smut, while the highest percentage in any plat did not exceed 4.5 per cent.

The results of the experiment, when compared as to yield, are no less interesting. In all cases the treated seed gave the largest yield of both straw and grain. On an average the increase amounted to about 32 per cent. for the grain and 22 per cent for the straw. It will be noticed that the increase of grain is considerably more than enough to replace all the smutted heads. This extra increase is one of the most interesting features of the process, and well worth the attention of cultivators quite independent of the question of smut.

A large amount of laboratory work has been done to determine the cause of this extra yield from seed which has been subjected to the hot water treatment The conclusion has been reached that it is due to the conversion of inactive into active enzym by the hot water. The function of the enzym is to dissolve the starch and render it available for the growth of

the young plant. The seed in the natural course of germination develops the enzym slowly, but the hot water makes a much larger amount available at the outset; the plantlet grows more vigorously, and the final yield is affected accordingly.

Farmers who have already tried this treatment have reported upon it favorably. It is destined to come into general practice as soon as its merits are more fully understood and appreciated. The process is very simple: Put a half bushel or more of seed into a loosely woven bag, so that it will not be much over half full when tied. Drop this into a barrel of water heated to about 145°, and stir it about so that the seed will be evenly warmed. In about eight minutes remove the seed from the water and spread it out to dry. Bring the water in the barrel up to 145° again, and it is ready for a second lot of seed. This treatment removes the smut and greatly increases the yield.

WHEAT—A more extended test than heretofore tried was made with the hot water treatment for the loose smut in wheat. The result was uniform with previous trials; no material decrease of smut was to be noticed. This seems all the more remarkable as the treatment is a thoroughly efficient remedy for hard or stinking smut in wheat, as the work of previous years has shown. It must be recognized, however, that at present there is no remedy for loose smut in wheat known.

BEETS—Very considerable work has been done upon the diseases of the sugar beet and the larger part of the results have already appeared in Bulletin No. 39. Some experiments have been completed since that account was published, one of the most interesting of which has proven that beets will become scabby if grown in soil from which a crop of scabby potatoes has been removed. This experiment was carried out with plants grown in a cool greenhouse.

CARNATIONS—The diseases of carnations have received much attention. The chief ones brought under study are rust, spot and a bacterial disease. The department has recommended a course of treatment based upon the investigations which have been made, and it is very gratifying to observe that since February, when it was first brought to the general attention of

carnation growers, at the meeting of the American Carnation Society, held in Buffalo, N. Y., it has come into quite general use. It is believed that the department in this instance has done a most valuable service to florists.

POTATOES—Several trials were made to prevent the scabbing of potatoes. The tubers were treated with solutions of ammoniated copper carbonate, potassium sulphide and corrosive sublimate, being immersed for a half hour, and for six hours in each case. The copper and potassium solutions did not prove particularly effective. The corrosive sublimate, however, gave 88 per cent. of tubers wholly free from blemish, against 46 per cent. untreated. The treated and untreated seed were planted in alternating hills. The remedy is believed to be a thoroughly efficient and practical one, and will soon be given in detail to the public.

Preliminary trials have been successfully carried out in the study of the value of several phosphate plant foods in increasing the yield of potatoes. These trials were made in a cool greenhouse not entirely adapted to the purpose. The work will be more extensively prosecuted during 1893, as a vegetation house, designed especially for such investigations, will then be available.

The investigations upon the preparation and planting of potatoes have been continued in the same elaborate manner as in 1890 and in 1891. The amount of data already accumulated is very large, and the time is approaching when it will be possible to settle many questions of practice with a certainty that has never before been attainable. A bulletin upon the relation between the number of eyes upon the seed tuber and the yield was issued during the year as No. 42. Beside the method of cutting the seed tuber and the number and size of the pieces in a hill, attention has also been given this season to the distance apart of the hills in a row, and to the use of numerous varieties in testing some of the methods.

Respectfully submitted,

J. C. ARTHUR,
Botanist.

REPORT OF THE AGRICULTURIST.

To C. S. Plumb, Director:

During 1892 the work of the Agriculturist has been devoted exclusively to the continuation of experiments previously begun. The following is a brief outline of this work.

I. Experiments with Varieties.

1. *Wheat.*—Number of varieties tested in 1892, thirty-two; time under trial, one to nine years; average yields, twenty-five to forty-two bushels; yields in 1892, eighteen to thirty-nine bushels; leading varieties, Jones' Winter Fife, Early Red Clawson, Velvet Chaff (brown smooth), Valley, Raub's Black Prolific; promising new varieties, Jones' Winter Fife, Early Red Clawson, Willits.

2. *Corn.*—Number of varieties tested in 1892, thirty-four; time under trial, two to six years; average yields, forty to seventy-five bushels; yields in 1892, twenty-one to ninety bushels; leading varieties, White Prolific, Boone County White, Yellow Nonesuch, Riley's Favorite, Haben's Golden, Purdue Yellow.

3. *Oats.*—Number of varieties tested in 1892, twenty-five; time under trial, one to four years; average yields, thirty-four to seventy bushels; yields in 1892, thirty-four to fifty-six bushels; leading varieties in 1892, Improved White Russian, White Swede, Giant Yellow, Wide Awake, White Superior Scotch.

II. Experiments with Thick and Thin Sowing and Planting.

1. *Wheat.*—Quantity of seed, two to eight pecks per acre; time under trial, eight years; range of average yields, twenty-two to thirty-one bushels; range of yields in 1892, twenty-four to twenty-eight bushels; highest average yield produced from eight pecks per acre; lowest average yield produced from two pecks per acre.

2. *Oats.*—Quantity of seed, four to twelve pecks per acre; time under trial, seven years; range of average yields, forty-six to fifty-one bushels; range of yields in 1892, fifty-two to

fifty-six bushels; highest average yield produced from eight pecks per acre; lowest average yield produced from five pecks per acre.

3. *Corn.*—Thickness of stand ranged from eleven to twenty inches between individual stalks, which were planted in drills three feet and eight inches apart; time under trial, six years; range of average yields, forty-six to fifty-five bushels; range of yields in 1892, thirty-nine to fifty bushels; highest average yield produced from stalks eleven inches apart; lowest average yield produced from stalks twenty inches apart.

III. Experiments With Early and Late Sowing and Planting.

1. *Wheat.*—Range of dates, September 18 to October 18; time under trial, four years; range of average yields, twenty-two to thirty-three bushels; yield from earliest sowing, thirty-three bushels; yield from latest sowing, twenty-two bushels.

2. *Corn.*—Range of dates, May 1 to May 29; time under trial, four years; range of average yields, forty-one to fifty-three bushels; yield from earliest planting, fifty-three bushels; yield from latest planting, forty-one bushels.

IV. Experiments With Deep and Shallow Plowing for Corn.

This experiment was commenced in the spring of 1891. Range of depth of plowing, four to twelve inches; range of average yields, fifty-one to fifty-five bushels; highest average yield from plowing eight inches deep; lowest average yield from plowing four inches deep

V. Experiments With Deep and Shallow Cultivation of Corn.

Range of depth, one to three inches; time under trial, four years; average yield from cultivation one inch deep, sixty bushels; cultivation two inches deep, fifty-five bushels; cultivation three inches deep, fifty-three bushels.

VI. Experiments With Different Corn Cultivators.

Number of implements tested in 1892, six; time under trial, one to five years; three distinct types of cultivator were used, viz.: The common two-horse corn plow with two shovels in each gang, the spring-tooth cultivator with five teeth in each gang, and the "Gopher" (three forms), which merely shaves below the surface and tends to draw the earth toward the corn row. Average yields of corn: With corn plow, fifty-five bushels; with spring-tooth cultivator and "Gopher," each fifty-seven bushels.

VII. Experiments to Determine Effect of Previous Manuring on Yield of Corn.

Gas lime, a low grade of ammoniated phosphate and fresh horse manure were applied in 1883 and in 1884 to ground that has been producing corn continuously since 1880 to the present. There has been no fertilization before or since the years named above. Nine crops of corn have been removed since the first application of manure and fertilizer. The gas lime and phosphate have had practically no effect on the yield. The average gain per acre from the horse manure has been over twelve bushels: gain from horse manure in 1892, about seven bushels; aggregate gain from horse manure in nine years, nearly one hundred and seven bushels.

VIII. Experiments With Rotative Cropping and Continuous Grain Growing Without Manure.

Corn, oats and wheat are grown continuously on series H. The same grains, in connection with beans, roots and grass, are grown in rotation on series F. The entire crop is harvested and removed in every case. The average yields of the staple grains for the last four years are as follows: Series F—Corn, thirty-four bushels; oats, thirty-three bushels; wheat, twenty-two bushels. Series H—Corn, thirty bushels; oats, twenty-eight bushels; wheat, sixteen bushels. Average gain per acre from rotative cropping: Corn, four bushels; oats, five bushels; wheat, six bushels.

IX. Experiments With Full and Two-thirds Applications of Manure and Fertilizers.

The purpose of these experiments is to determine (1) the maximum limits of crop production and (2) the relative economy of heavy and light manuring. Fresh stable manure and high grade commercial goods were used in these trials. Time of trial, three years; average gains in bushels per acre of the several grain crops as follows:

Applications.	*Barley.*	*Corn.*	*Oats.*	*Wheat.*
Full applications of fertilizers	12.3	10.6	2.5	7.6
Two-thirds applications of fertilizers . . .	9.1	13.7	3.3	6.7
Full applications of manure	8.2	13.3	11.7	5.9
Two-thirds applications of manure	8.6	11.9	9.4	5.2

X. Experiments With Complete and Partial Fertilizers and Manures.

By "complete" fertilizer is meant one containing a sufficient amount of phosphoric acid, potash and nitrogen to meet the demands of a full crop; by a "partial" fertilizer is meant one containing but one or two of the above named ingredients in sufficient quantities for a full crop. The experiment has been continued but two years, hence the results which are given below are not at all decisive.

	Oats.	*Wheat.*
Average yield from complete fertilization	29.3 bu.	31.5 bu.
Average yield from partial fertilization	26.0 bu.	32.5 bu.

It will take some years yet to secure satisfactory results from this line of experiments.

Respectfully submitted,

W. C. Latta,
Agriculturist.

The Agricultural Experiment Station of Indiana in Account with the United States for the Year Ending June 30, 1892.

DEBIT.		
Appropriation		$15,000 00
CREDIT.		
Stock	$377 50	
Repairs	86 07	
Apparatus and fixtures	736 34	
Printing, stationery and bulletins	858 16	
Books	199 03	
Care of buildings	385 00	
Labor	3,372 54	
Postage	62 82	
Express, freight and hauling	170 21	
Gas	50 70	
Advertising	26 80	
Supplies	2,374 77	
Salaries	6,286 93	
Telegrams	3 13	
Miscellaneous	10 00	
Total		15,000 00

The above is a correct statement of the expenditures in the General Fund of the Agricultural Experiment Station of Indiana for the year ending June 30, 1892.

E. A. Ellsworth,
Secretary Board of Trustees.

Improvement Fund Experiment Farm for Year Ending June 30, 1892.

DEBITS.		
Balance unexpended June 30, 1891	$730 03	
Receipts from farm	1,993 31	
Total		$2,723 34
CREDITS.		
Traveling expenses	$65 73	
Supplies	233 75	
Salaries	988 98	
Repairs	16 35	
Improvements	10 50	
Insurance	17 00	
Printing and stationery	98 25	
Apparatus and fixtures	17 00	
Labor	332 99	
Care of buildings	35 00	
Balance unexpended	907 79	
Total		2,723 34

The above is a correct statement of the expenditures in the Improvement Fund for year ending June 30, 1892.

E. A. Ellsworth,
Secretary Board of Trustees.

PURDUE UNIVERSITY.

SIXTH ANNUAL REPORT

OF THE

Agricultural Experiment Station,

LAFAYETTE, IND.

1893.

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.
1894

THE STATE OF INDIANA,
GOVERNOR'S OFFICE,
January 29, 1894.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

JANUARY 29, 1894.

Transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

MYRON D. KING,
Private Secretary.

Filed in the office of the Secretary of State of the State of Indiana, January 29, 1894.

W. R. MYERS,
Secretary of State.

Received the within report and delivered to the printer January 29, 1894.

CHRIS. H. STEIN,
Clerk Printing Bureau.

To the Governor:

I herewith transmit the annual report of the Purdue University Agricultural Experiment Station, due February 1, 1894.

Very respectfully,

C. B. STUART,
President Board of Trustees.

JANUARY 26, 1894.

To the President of the Board of Trustees:

I herewith present the annual report of the Agricultural Experiment Station of Indiana, due on or before the 1st of February, 1894, the same being required by section 3 of an act entitled "An act to establish agricultural experiment stations in connection with the colleges established in the several States, under provisions of an act approved July 2, 1862, and of the acts supplementary thereto."

This report consists of a report of the Director of the Station, and the financial report of the Secretary to the Board of Trustees.

Respectfully submitted,

J. H. SMART,
President.

PURDUE UNIVERSITY, LA FAYETTE, IND., January 26, 1894.

BOARD OF CONTROL.

CHARLES B. STUART, President, - - - -	La Fayette.
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JAMES H. SMART, LL. D.,
President of the University.

EDWARD A. ELLSWORTH,
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STATION STAFF.

CHARLES S. PLUMB, B. S., - -	Director.
WILLIAM C. LATTA, M. S., - -	Agriculturist.
JAMES TROOP, M. S., - - - -	Horticulturist.
HENRY A. HUSTON, A. M., A. C.,	Chemist.
JOSEPH C. ARTHUR, D. Sc., - -	Botanist.
ARVILLE W. BITTING, B. S., -	Veterinarian.
GEORGE R. IVES, B. S., - - - -	Assistant Agriculturist.
S. GRANT WRIGHT, M. S., - -	Assistant Botanist.
WILLIAM BRADY, B. S., A. C., -	Assistant Chemist.

SIXTH ANNUAL REPORT

OF THE

Purdue University Agricultural Experiment Station.

REPORT OF THE DIRECTOR

To President James H. Smart:

SIR—I have the honor to herewith transmit to you the Sixth Annual Report of the Purdue University Agricultural Experiment Station for the year 1893.

The Station Staff of officers has been subject to some change during the year, especially in the case of assistants. Dr. W. L. Williams, in charge of Veterinary work, was succeeded on July 1 by Mr. Arville W. Bitting, B. S., a graduate of the School of Agriculture of Purdue in 1891, who resigned the Chair of Veterinary Science in the Florida Agricultural College to accept the position formerly held by Dr. Williams. Miss Katherine E. Golden, who has acted as Assistant Botanist for three years ending July 1, in a most faithful and acceptable manner, resigned to become Assistant in Biology in the University, and the vacancy thus created was filled by the appointment of Mr. S. Grant Wright, M. S., a graduate of Purdue in the School of Science, who had been acting as Assistant Biologist in the University during the year 1892–93. As Mr. Wright had been employed temporarily in the station botanical work previous to this time, he was especially fitted to take up the duties of assistant.

On September 1, Mr. W. F. McBride, who had acted as a most competent Assistant Chemist for the year previous, resigned to take up another line of work, and up to January 1, Mr. William Brady, B. S., A. C., a graduate of Purdue in 1887, has performed the work of Assistant.

An important addition was made to the officers in July, by the appointment of an Assistant Agriculturist, Mr. George R. Ives, of the class of 1893, School of Agriculture, Purdue University. The necessity of an assistant in this department has been manifest for some time, as there has been a material increase in the combined field, stable and dairy experimental work. The services of the assistant are mainly devoted to the field work in summer and the stock feeding and dairy investigations in winter.

The Experimental Work of this Station has for some years been conducted with considerable stability of purpose, it being thought wise to pursue certain lines of investigation for a term of years, thus covering many variations caused by climatic and other conditions; this especially appertains to those experiments conducted entirely or in part in the field. In view of this fact, there is much in the work of all the departments which is a practical duplication of the previous season's work.

The growing season of 1892 was marked by excessive moisture at planting, and serious drought in the summer, consequently field work was, in a measure, unsatisfactory. During June, July and August, the present year, however, occurred one of the most serious droughts which has ever affected this region, so that much field work was an absolute failure. The rainfall was 1.55, 1.10 and 0.77 inches respectively for June, July and August, far below the normal rainfall, and entirely insufficient to maintain normal crop growth. As a result of this lack of rainfall, seeds planted in July would not germinate for weeks, our corn crop was almost a failure, the pastures were completely dried up, and vegetation generally suffered to an excessive degree. It seems to be essential that a water supply be made available to certain fields, so that in case of such drought, experimental work of a season may not be ruined through lack of soil moisture, and that the beneficial effects of irrigation in such an emergency be shown to Indiana farmers.

The sugar beet investigations being conducted by the Chemist have suffered during the past two seasons, owing to the

weather conditions, and yet a fair crop of beets has been harvested each season, with results of considerable promise for the future. Seed was sent to 126 different points in the State, to be planted and crop cared for under the directions furnished by the Station, and samples were received from 26 stations for analysis. The results of investigations, conducted in the main by this Station, have prompted a certain sugar syndicate to offer seed free to 200 farmers in Indiana, who will grow one acre of sugar beets each under its directions during 1894. The purpose of this is to ascertain how successfully sugar beets can be raised in this State on a large scale, having in view the establishment of a beet sugar factory. This furnishes an interesting phase of the sugar beet question as applied to Indiana, showing the trend this subject is taking at the present time, the outcome of which will be noted with great interest by the people of Indiana.

There has been a continuation of the study of the unproductive soils of the State, and considerable chemical work has been done in that connection. In view of the importance of this subject, this work will be continued, both in field and laboratory, during 1894.

Of more than passing interest are the investigations of the Chemist bearing upon the determination of crude fibre in feeding stuffs. The present methods of determining this substance are unsatisfactory, and our knowledge of the feeding value of crude fibre is perhaps based on a too insecure knowledge of its true influence on the animal body. The work being conducted at this Station, it is believed, will throw important additional information upon this subject. Already considerable analytical data have been published in Bulletin 46, issued last September.

Two important problems concerning the potato crop have been investigated by the Botanist. The relationship of the number of eyes on a piece of tuber or an entire potato to the resulting crop has been considered in continuation of the work of previous years. The subject of potato scab has also been given careful attention, with eminently satisfactory results. Uncut seed potatoes soaked in a solution of corrosive sublimate for two or three hours produced a crop comparatively free of scab.

The work of the Agriculturist and Horticulturist suffered

especially from the dry weather already referred to, so much so that important work planned by the latter was entirely infeasible, and had to be given up.

Dairy investigations have been continued during the year and one bulletin published on this subject. This work involved a consideration of the following investigations: The setting of milk in shallow pans and deep cans; the creaming of milk from deep cans by different methods; the dilution of milk with water at different temperatures to facilitate creaming; the aeration of milk; the churning of cream at different temperatures.

Feeding experiments upon milch cows, to cover an extended period of time, were begun late in the year. Calf-feeding experiments have been in progress more or less during 1893. For the first time, this year the experimental feeding of sheep has been undertaken.

There has been a general concentration of work on a few lines by each department, and on the whole the work for 1893 may be viewed as a material improvement over that of the past.

Permanent Improvements have been made to some extent. A glass house for the shelter of plants grown under control conditions in pots, has been erected as an addition to the equipment of the Botanical Department. This structure is twenty feet wide and fifty feet long, with a set of doors ten feet high on the north side. When the weather is suitable the plants growing in pots or boxes may be moved on trucks outside of the house, and subjected to the ordinary atmospheric influences, excepting rainfall, all the moisture being supplied in special amount by the experimenter. The purpose of the house is to shelter the growing plants from rain and injurious winds.

Several hundred rods of new fencing have been built, leaving the experimental grounds well protected from the inroads of wandering stock. It will be necessary to build some new fencing during 1894 along the south side of the highway passing by the University.

The Publications of the Station during the year have consisted of two one page newspaper bulletins and five regular pamphlet bulletins, and the annual report. These are as follows, and the subjects discussed are given as shown on the title pages of the documents referred to:

Newspaper Bulletin No. 4, April 22, 1893. Tests of varieties of Sweet Corn. By James Troop, Horticulturist.

Newspaper Bulletin No. 5, August 3, 1893. Tests of varieties of Strawberries. By James Troop, Horticulturist.

Bulletin No. 43, Vol. IV, March, 1893, pp. 20. (a) Field experiments with corn. (b) The sugar beet in Indiana.

Bulletin No. 44, Vol. IV, May, 1893, pp. 21–44, figs. 5. (a) Upon deep versus shallow setting of milk. (b) Upon surface versus bottom creaming. (c) Cream raising by dilution. (d) Concerning the aeration of milk. (e) The baby separator in the private dairy.

Bulletin No. 45, Vol. IV, August, 1893, pp. 45–67. (1) Field experiments with wheat. (2) Forms of nitrogen for wheat.

Bulletin No. 46, Vol. IV, September, 1893, pp. 68–85, fig. 1. (1) A modification of Grandeau's method for the determination of humus. (2) Preliminary investigations relating to the determination of "crude fibre."

Bulletin No. 47, Vol. IV, November, 1893, pp. 86–101, figs. 2. (1) Does it pay to shelter milch cows in winter? (2) Upon skim milk as food for calves.

The above bulletins deal entirely with experimental research conducted at the Station.

The past year has shown an interesting increase in interest in the Station, and its work, not only by Indiana farmers, but, also, by farmers in many of the States and Territories. Each year there is a considerable demand for the results of the cereal experiments published in our bulletins, while the last bulletin of the year, concerning the shelter of dairy cattle in winter, has been in so great demand that the supply is about exhausted. The growth of the Station mailing list, as shown in the following figures, is due in a very large degree to personal written applications.

STATION MAILING LIST.

Number Names on List of	*On Jan. 18, 1893.*	*On Jan. 4, 1894.*
People in Indiana	5,741	7,131
Indiana periodicals	635	668
People in other States	1,158	1,316
Periodicals in other States	83	91
Foreigners	26	51
Foreign periodicals	7	7
	7,650	9,264

The largest number of bulletins printed in the past has been 10,000, but it will be necessary to exceed this edition beginning with 1894.

Each year numerous gifts are made the Station by individuals and institutions, and also publishers, especially of agricultural journals. In this connection I take pleasure in thanking those who have presented the Station with the following gifts during the year 1893:

MISCELLANEOUS GIFTS.

J. M. Thorburn & Co., New York City. Flower and garden seeds.

W. Atlee Burpee & Co., Philadelphia. Flower and garden seeds.

Henry Wallace, Des Moines, Iowa. "Clover Culture."

F. E. Myers & Bro., Ashland, Ohio. Bucket spray pump.

C. M. Winslow, Esq , Sec. American Ayrshire Association, Brandon, Vt. One male and one female pure bred Ayrshire calves.

J. D. French, North Andover, Mass. One Ayrshire heifer, pure bred.

Prof. C. H. Fernald, Amherst, Mass. Mounted collection of the Gypsy moth in different stages of development.

United States Department of Agriculture, Washington, D. C. Numerous seeds and publications.

T. J. Groves, Dana, Ind. Sterling seed corn.

J. H. Samuelson, Opheim, Ill. Uphome Queen seed corn.

James Riley, Thorntown, Ind. Riley's Favorite and other varieties of corn.

S. W. Dungan, Franklin, Ind. Dungan's corn and Yellow Nonesuch corn.

Northrup, Braslan & Goodwin Co., Minneapolis, Minn. Seeds.

J. A. Foote, Terre Haute, Ind. Seed corn.

W. I. Marshall, Chicago, Ill. Ruggle's Rotary cultivator.

D. F. W. Dafert, Campinas, Brazil. Relatio Annual do Instituto Agronomico do Estado de Sáo Paulo, 1892.

C. Mitzky, Rochester, N. Y. "Our Native Grape."

Jno. I. Gordon, Sec., Mercer, Pa. Vol. II, Hampshire Down Sheep Flock Record.

Imperial Japanese Commissioners, Jackson Park, Chicago, Ill. Numerous books and seeds.

L. E. Mace, Lexington, Ind. Garden hoe.

Farmers' Seed Company, Chicago, Ill. Seed wheat.

Francisco I. San Roman, Chili, S. A. Eight hundred pounds nitrate of soda.

Howard H. Keim, Sec, Ladoga, Ind. Vol. I, Flock Book Cheviot Sheep Breeders' Association.

Leavitt Manufacturing Co., Hammond, Ill. Dehorning clipper.

L. B. Townsend, Sec., Ionia, Mich. Vol. I, American Rambouillet Sheep Record.

Mortimer Levering, Sec. American Shropshire Sheep Association, La Fayette, Ind. One Shropshire ram. Vol. I, American Shetland Pony Stud Book.

J. D. Fredericksen, Little Falls, N. Y. "Creaming Milk by Centrifugal Force."

W. H. Morris, Sec., Indianapolis, Ind. Vols. I, II, III, The Chester White Record; Vols. XIII, XIV, Central Poland China Record.

Geo. W. Rafter, Rochester, N. Y. Numerous pamphlets.

Thomas B. Wales, Sec., Boston, Mass. Vols. IX, X, XI, Holstein-Friesian Herd Book of America.

W. A. Shafor, Secretary, Middletown, Ohio. Vols. III, IV, V, American Oxford Down Sheep Record.

Thomas McFarlane, Secretary, Harvey, Ill. Vols. I, II, III, IV, American Aberdeen Angus Herd Book.

S. Hoxie, Secretary, Yorkville, New York. Vols. I, II, III, IV, Holstein-Friesian Advanced Register.

Italo Giglioli, Portici, Italy. Numerous documents.

PERIODICALS.

Agricultural Gazette of New South Wales	Sidney, Australia.
Agricultural Epitomist	Indianapolis.
American Agriculturist	New York City.
American Bee Journal	Chicago, Ill.
American Cultivator and Poultry Keeper	Los Angeles, Cal.
American Florist	Chicago, Ill.
American Grange Bulletin	Cincinnati, Ohio.
American Sheep Breeder and Wool Grower	Chicago, Ill.
Baltimore Sun (Weekly)	Baltimore, Md.
Breeders' Gazette	Chicago, Ill.
Clover Leaf	South Bend.
Creamery and Dairy	Waterloo, Iowa.
Creamery Journal	Waterloo, Iowa.
Dairy Messenger	Chicago, Ill.
Drainage Journal	Indianapolis.
Elgin Dairy Report	Elgin, Ill.
Experiment Station Record	Washington, D. C.
Farm and Fireside	Springfield, Ohio.
Farm and Home	Chicago, Ill.
Farm, Field and Fireside	Chicago, Ill.
Farm Journal	Philadelphia, Pa.
Farmers' Advocate	London, Ont., Can.
Farmers' Call	Quincy, Ill.
Farmers' Guide and Home Companion	Huntington, Ind.
Farmers' Home	Dayton, Ohio.
Farmers' Review	Chicago, Ill.
Good Roads	New York City.
Grange Visitor	Lansing, Mich.
Hoard's Dairyman	Ft. Atkinson, Wis.
Holstein-Friesian Register	Brattleboro, Vt.
Home and Farm	Louisville, Ky.
Home Journal	La Fayette.
Hospodar	Omaha, Neb.
Indiana Farmer	Indianapolis.
Industrial American	Lexington, Ky.
Industrialist	Manhattan, Kan.
Insect Life	Washington, D. C.

Jersey Bulletin	Chicago, Ill.
Journal of Agriculture	St. Louis, Mo.
Journal of Mycology	Washington, D. C.
Kansas Farmer	Topeka, Kan.
La Fayette Commercial Gazette	La Fayette.
Louisiana Planter and Sugar Manufacturer	New Orleans, La.
Mennonitische Rundschau	Elkhart.
Michigan Farmer	Detroit, Mich.
Milling	Chicago, Ill.
Mirror and Farmer	Manchester, N. H.
National Sheepman	Indianapolis.
National Stockman and Farmer	Pittsburgh, Pa.
Nebraska Bee Keeper	York, Neb.
Nebraska Farmer	Lincoln, Neb.
New England Farmer	Boston, Mass.
Ohio Farmer	Cleveland, Ohio.
Orange Judd Farmer	Chicago, Ill.
Pacific Rural Press	San Francisco, Cal.
Practical Farmer	Philadelphia, Pa.
Prime's Crop Bulletin	Dwight, Ill.
Rural Northwest	Portland, Ore.
Southern Cultivator and Dixie Farmer	Atlanta, Ga.
Stock and Farm	Bunker Hill.
Sugar Beet	Philadelphia, Pa.
Swine Breeders' Journal	Indianapolis.
Wayne Farmer	Hagerstown.
Western Swineherd	Geneseo, Ill.
Wisconsin Agriculturist	Racine, Wis.

I herewith append the reports of the several departments of the Station, briefly outlining the work of the year. In some cases results secured from experiments are given, while in others the progress of the work will not justify the drawing of conclusions.

Respectfully submitted,

C. S. PLUMB,

Director.

REPORT OF THE CHEMICAL DEPARTMENT.

To C. S. Plumb, Director:

The following is a brief outline of the work of the Chemical Department for the year 1893:

SUGAR BEET.

Field and laboratory work has been continued on this subject. Both spring and summer climatic conditions were extremely unfavorable to the field work. Seed was sent to every county in the State, and there were 126 stations in all to which free seed, with full culture directions, was furnished. Samples were received from 26 stations, a fair showing for such an unfavorable season While the past two years have been very unfavorable to beet culture, yet the results obtained are of considerable value in that they show that conditions that are practically fatal to the corn crop will still permit a fair beet crop to mature. The low price of wheat and corn has turned the farmers' attention to the question of other crops, and an increased interest in the sugar beet question has arisen. The results of the year's work on the subject are practically ready for publication.

UNPRODUCTIVE SOIL.

The land of one of the farms, where the work on this subject was conducted in 1892, has been under observation during this year. No treatment of the land was made this year, the object being to learn whether the last year's treatment would give results extending over more than one year. While the conditions were not such as to permit of quantitative measurement on the plats this year, the character of the crop indicates that the effect of last year's treatment has continued. The work will be extended the coming season by the application of special drainage; the preliminary survey for this has already been made.

FORMS OF NITROGEN FOR WHEAT.

This work was continued along the same lines as in 1891 and 1892, with the addition of plats for coarse manures. The results for 1893 confirmed those for the two preceding years, but the value of the result this year is reduced owing to serious injury by rust which interfered with the normal ripening of the grain.

FORMS OF PHOSPHATES FOR CORN.

Corn was planted on the plats where various phosphates had been applied in 1891 and 1892, but this crop was a failure owing to the severe drought.

METHODS FOR THE DETERMINATION OF HUMUS.

In connection with the examination of soils, attention was drawn to difficulties in determining humus in some of the soils under examination. On this account a somewhat full examination into the factors involved in the determination of humus was made. A method which is generally practicable was worked out and special apparatus devised which reduces to a great extent the labor involved in the work and gives more constant working conditions. A detailed account of this work has already been published as a station bulletin. (No. 46, Sept., 1893.)

METHODS FOR THE DETERMINATION OF CRUDE FIBRE.

The official methods for fibre determination in feeding stuffs are not considered satisfactory. In connection with the examination of a considerable number of different kinds of feeding material the action of a large number of solvents was tried and results were obtained which are believed to be of considerable value. The work is still in progress, although the results so far obtained (Jan. 1) have been published in bulletin form.

NUTRITIVE VALUE OF FUNGI.

The total nitrogen and the albuminoid nitrogen of fourteen varieties of fungi have been determined The results indicate that much of the nitrogen is not in the form of albuminoids, and work is in progress to determine the class of compounds containing the non-albuminoid nitrogen in the fungi.

SPECIAL WORK ON PHOSPHATES.

The increasing use of phosphates causes a deeper interest to be taken in the value of phosphorus from different sources. Special work is in progress for the purpose of devising additional methods for determining the source of phosphorus in mixed fertilizers and for detecting adulteration in non-acidulated goods.

FERTILIZER INSPECTION.

Numerous examinations of samples of commercial fertilizers from purchasers have been made. This work, however, has been divided between the Station and the State Chemist. The results indicate that the present fertilizer law is sadly in need of an amendment providing for inspection of all fertilizers in the market instead of in the factory.

MISCELLANEOUS.

The usual amount of work for different departments of the Station has been done, and many examinations, qualitative and quantitative, have been made of material sent to the Station.

Both in amount and quality the work of this Department for the past year has been more satisfactory than that of any year since the establishment of the Station.

The following is a summary of the quantitative analyses made in connection with the above work:

Sugar beets	149
Humus	211
Potash in humus	30
Phosphoric acid in humus	50
Fibre	242
Nitrogen in fibre	89
Nitrogen in fungi	82
Nitrogen in wheat	64
Phosphates	163
Fertilizer inspection	41
Miscellaneous	135

Very respectfully submitted,

H. A. HUSTON,

Chemist.

REPORT OF THE BOTANICAL DEPARTMENT.

To C. S. Plumb, Director:

The work of the Department during 1893 has been carried on in much the same lines as in preceding years. The subjects of investigation have been mainly those pertaining to plant diseases and physiology. Although, owing to unusual interruptions, not as much experimental work has been brought to a serviceable conclusion as the Department has established for its customary annual returns, yet highly valuable data have been gathered, and considerable preparatory work has been accomplished to aid in the investigations of subsequent years.

The Department made a display of some of its physiological apparatus at the World's Fair, requiring a considerable outlay of time to prepare and to care for after being sent to Chicago. This exhibit occupied a case two and one-half by seven feet and seven feet high, forming part of the Collective Agricultural College and Station Exhibit displayed in the Agricultural Building. The exhibit proved a very attractive one to visitors, and elicited much careful attention and study. Beside the service to the general public, it has been learned in various ways that many investigators received benefit from the display. The Department has had numerous inquiries regarding the separate pieces exhibited, both as to the special detailed methods of using them and as to the dealers who supply such apparatus. It is believed, therefore, that the labor and time employed in preparing and maintaining the display were well expended, and that the effort has proved, and will continue to prove, of genuine service in promoting a general knowledge of the subject of vegetable physiology, and in aiding investigation.

Experiments and observations have been conducted by the Department, since 1889, upon one phase of the profitable cultivation of tomatoes, viz., the use of immature seed for the purpose of increasing earliness and productiveness. A large amount of work in this line was done in 1889 and 1890, less in 1891, and still less in 1892 and 1893. The reason for this apparent decrease of attention was largely the want of a satisfactory clue to the real relationship of the facts to the known

laws of plant reproduction. It was felt to be a misappropriation of energy to test the question largely as a purely empirical method, while unable to bring the results into harmony with known laws, hence the falling off in time and labor devoted to the matter. In the winter of 1892–3 careful observations were made upon tomato plants grown and matured in the greenhouse from seed taken from fruit not over half grown and only allowed to dry a few days after removal from the fruit before planting, the seed-coats being too soft and immature to keep the seed from speedily drying out and dying, if kept long in dry air. Comparison was made with plants grown under the same conditions from mature seed taken from the same parent plant at the same time and subjected to like treatment. This experiment was not in itself remarkable, but, taken with what had preceded it, it suggested an explanation of the true relationship of the facts already ascertained, and afforded what appeared to be a reliable guide to further study of the subject. The main facts brought out in these researches, and similar data gathered from the work of other investigators, together with the argument founded upon them, were embodied in a paper entitled, "Deviation in Development Due to the Use of Unripe Seed," presented before the American Association for the Advancement of Science, at its meeting in Madison, Wisconsin, August, 1893. This paper will eventually appear in full in the *American Naturalist.* The conclusion reached in the paper was, in brief, that the principal deviations arising from the use of immature seed are: (1) a loss of vigor, shown in the smaller percentage of germinations, weakness of the seedlings, and greater number of plants which die before maturity; (2) failure to recover lost vigor, although the plants may, and usually do, produce an abundant harvest, and one acceptable to the cultivator; (3) the increase of reproductive parts in proportion to the vegetative parts, resulting in a greater number of fruits and seeds (although individually smaller), and more rapid ripening, than in similar plants from mature seeds. The explanation of these facts was found in the generalization that "any cause which retards uniform progress in the development of a plant or animal favors reproduction." We learn from this that the greater productiveness and earlier ripening of tomatoes grown from seed taken from green fruit is not accidental, but is to be expected as a uniform result; furthermore,

that the weakening of the plant is also to be expected as a necessary accompaniment. Whether sufficient vigor of plant can be secured by this method of increasing earliness and productiveness to make it a profitable one in commercial gardening is a question not yet fully investigated.

Another paper bearing upon this subject, and in part growing out of it, has been the result of the year's activity. It was presented before the Society for the Promotion of Agricultural Science at its August, 1893, meeting in Madison, Wis., under the title "A New Factor in the Improvement of Crops," and was published in *Agricultural Science* for Aug.-Sept., 1893, and also in the proceedings of the Society for 1893 (pp. 17-21), issued some time since. The paper deals particularly with the reciprocal relation between the two parts of a plant, *i. e.*, vegetative (leaf, stem, root) and reproductive (seed, fruit), under varying conditions of growth. The generalization is reached that "a decrease in nutrition of an organism favors the development of the reproductive parts at the expense of the vegetative parts." The decrease in nutrition may be brought about by poor soil, bad tillage, slow germination, etc., all leading to the same general result. But it was pointed out that while partly starved plants are, as a rule, proportionately more productive (*i. e.*, per unit of vegetative part), the reverse is true of plants grown from large and small seeds, for "large seeds produce stronger plants with a greater capacity for reproduction than small seeds of the same kind." These conclusions, which are supported by experimental data, strongly emphasize the necessity of using only the largest seeds (that is, screening out and discarding the small seeds) for sowing, in order to secure not only the largest yield of grain and fruit, but also to retain the vigor and permanency of the race under high tillage.

It is believed that these generalizations will be of great value to intelligent farmers, and to investigators as well, in dealing with crops of all kinds.

The prevention of scab upon potato tubers has again received careful attention, and the results of the season's work fully confirm the favorable results obtained in 1892. The season was unusually dry and untreated seed material gave a crop having 55 to 70 per cent. of the tubers quite free from scab, but treated seed material gave 90 to 95 per cent. wholly free from scab. What small amount of scab appeared upon the treated portion

was for the most part in the shape of small scattered spots, and much less noticeable than that upon the tubers of the untreated portion. The treatment consists in soaking the uncut seed material for two to three hours in a solution of corrosive sublimate of the strength of two ounces to fifteen gallons of water. When the first lot of potatoes has been taken out of the bath, it may be employed for another lot, thus using the same solution over and over again until the full quantity of potatoes desired for planting has been treated. The importance of this remedy is now believed to be beyond all question and is confidently recommended as a certain and economical method for preventing scab, and thus improving the quality and commercial value of the potato crop. The data and details of the experiment upon which this conclusion is based have not yet been published.

Elaborate experiments upon the preparation and planting of potatoes were conducted during 1893, as has also been done for the three preceding years. The data obtained as a result of this work amounts to about two hundred manuscript pages of quarto size for each year since its inception. Very little of this data has yet been put into print. It is withheld in order to investigate the subject from many sides, and to be able to speak authoritatively when its treatment is undertaken.

During the year a vegetation house has been added to the equipment of the Department. It is a glass structure, twenty by fifty feet, with doors ten feet high opening along one side, through which the plants grown in pots or boxes placed upon trucks may be wheeled into the open air in fair weather and returned to cover during inclement weather. It is without heating apparatus, and is designed for use chiefly in summer, although experiments upon winter wheat, begun in October, are progressing finely at the time this is written (January, 1894). The purpose of a vegetation house is to enable the experimenter to more perfectly control the conditions surrounding the plants under cultivation than can be done in field culture. It will be used chiefly in experiments with wheat, oats, corn, potatoes and other field crops.

Respectfully submitted,

J. C. ARTHUR,

Botanist.

REPORT OF THE VETERINARY DEPARTMENT.

To C. S. Plumb, Director:

The work of the Veterinary Department is being conducted along different lines this year from that previously pursued.

The therapeutic value of pilocarpine in cases of parturient apoplexy, the quantity and proper mode of administration, whether by a maximum dose at once or by a cumulative dose, are points which we have tried to determine. A number of cases occurred in the immediate vicinity of the Station during the fall on which to make the tests. As soon as the work can be duplicated a report will be made in full.

Experiments are in progress as to the use of different drugs for anæsthetic purposes on different domestic animals, the quantity required, mode of administration, and the dangers likely to arise from their use.

Investigations concerning the prevalence of blindness in horses, and the cause, were carried on during the fall and will be resumed again in the spring.

A collection of the animal parasites affecting stock in this State is being attempted.

Respectfully submitted,

A. W. BITTING,

Veterinarian.

REPORT OF THE HORTICULTURAL DEPARTMENT.

To C. S. Plumb, Director:

Much of the work of this Department has been a continuation of that already in progress for a number of years. Many of the Russian varieties of orchard fruits, set seven years ago, are coming into bearing, and will soon be in condition to report upon. It is the intention to use the best of these for crossing with our native varieties, as it is believed that by this means the greatest good will be secured from them for this climate.

The experiments with small fruits were seriously interfered with by the exceptionally unfavorable weather during the months of May and June. The meteorological records of the Experiment Station show that the mean temperature for the month of May was only 57.5 degrees F., which was much below the normal, and retarded plant growth very materially. The amount of rainfall was a little less than normal, but it was so distributed throughout the blossoming period that, when combined with the low temperature, it served to most effectually prevent perfect fertilization of blossoms, and so, much of the fruit was imperfectly developed.

Following this, during the last of May, the drought began, and continued throughout the growing season. The monthly rainfall for June, July and August was only 1.55, 1.10 and .77 inches, respectively, while the normal rainfall for each of these months is about 3.5 inches. This was far below the requirements of the plants during the ripening periods. Owing to these adverse conditions a number of experiments which were planned for last season were abandoned. Among these were experiments with fungicides and insecticides, and crossing and hybridizing fruits and vegetables. These will be taken up again during the coming season.

VARIETAL TESTS OF FRUITS AND VEGETABLES.

A large number of varieties of fruits and seeds have been sent to the Experiment Station for trial, and either have been, or will be, reported upon in the bulletins of this Department. They include eighty varieties of strawberries, besides

a large number of our own seedlings; twenty-five varieties of raspberries, twenty varieties of blackberries, twenty varieties of currants and gooseberries, sixty varieties of grapes, some of them crosses of native wild species; forty varieties of potatoes, twenty-five varieties of tomatoes, thirty varieties of beans, etc.

HORTICULTURAL SUB-STATIONS.

These sub-stations, which are located in the north-central and southern portions of the State, and which are under the control of experienced horticulturists, have carried on the work assigned to them in a very satisfactory manner, although the results have been somewhat disappointing on account of the adverse climatic conditions. New varieties have been sent each of them for trial as soon as received from the originators, and will be reported upon in due time.

IRRIGATION FOR SMALL FRUITS AND VEGETABLES.

Our experiments of the past season have demonstrated very clearly the necessity of adopting some means by which we may be able to regulate the supply of water furnished to our growing fruits and vegetables, wherever it can be done without too great expense. Many crops of small fruits and vegetables, which mature early in the summer, were almost completely ruined last season by the severe drought. These plants require a large amount of water during the ripening period to enable them to develop properly, and our experience has shown that it is not safe to rely solely upon the natural rainfall for this supply; not so much because of the insufficient amount, as of the lack of proper distribution; hence the chief value of irrigation in our climate comes from the fact that the farmer or gardener is able to supplement the natural rainfall, thus supplying the proper amount of water at the time when it will do the most good. The amount of water required is therefore small in comparison with those places where the entire crop is dependent upon an artificial supply. In view of the fact that this is coming to be an important question among the fruit growers of the State, it is suggested that greater facilities be supplied for careful experiments in this line during the coming year.

Respectfully submitted,

J. TROOP,

Horticulturist.

REPORT OF THE AGRICULTURIST.

To C. S. Plumb, Director:

All the lines of experiment conducted by the Agriculturist in 1892 were continued in 1893. The additional lines were spring mowing of wheat to prevent excessive rankness in growth of crop, improvement of corn, and relation of early and late planting of corn to time required to mature crop. The severe winter of 1892 1893 greatly reduced the yields of wheat, and the excessive and prolonged drouth during the summer of 1893 caused the partial or almost complete failure of the experiments with corn. Many of the lines of experiment are yet in their initial stages, and conclusions or even data, would be as yet premature.

The following is a brief statement of the work of the year with such showing of results as the progress of the work seems to justify.

I. EXPERIMENTS WITH VARIETIES.

1. *Wheat.*—Number of varieties tested in 1893, 35; time under trial, one to ten years; average yields, 21 to · 6 bushels; yields in 1893, 12 to 24 bushels; leading varieties in the order of their average yields, Jones' Winter Fife, Early Red Clawson, Velvet Chaff (brown smooth), Velvet Chaff (brown bearded), Raub's Black Prolific, Michigan Amber.

2. *Corn.*—Number of varieties tested in 1893, 25; time under trial, one to seven years; average yields (not including 1893), 40 to 75 bushels; owing to a shallow soil underlaid by gravel, and the intense drouth, many of the varieties of corn formed only imperfect ears or abortive shoots; the leading varieties based upon the work of previous years are White Prolific, Boone County White, Yellow Nonesuch, Riley's Favorite, Haben's Golden, Purdue Yellow.

3. *Oats.*—Number of varieties tested in 1893, 7; time under trial, one to five years; average yields, 32 to 64 bushels; yields in 1893, 25 to 89 bushels, the yields being considerably curtailed by the drouth; leading varieties in 1893, Giant Yellow, White (name unknown), Great Northern, Wide Awake, White Bonanza.

II. EXPERIMENTS WITH THICK AND THIN SOWING AND PLANTING.

1. *Wheat.*—Quantity of seed, two to eight pecks per acre; time under trial, eight years; range of average yields, 22 to 30 bushels; range of yields in 1893, 19 to 27 bushels; highest average yield produced from eight pecks per acre; lowest average yield produced from two pecks per acre.

2. *Oats.*—Quantity of seed, four to twelve pecks per acre; time under trial, eight years; range of average yields, 45 to 50 bushels; range of yields in 1893, 34 to 44 bushels; highest average yield produced from eight pecks per acre; lowest average yield produced from four pecks per acre.

3. *Corn.*—Thickness of stand ranged from eleven to twenty inches between individual stalks, planted in drills three feet eight inches apart; time under trial, seven years; range of average yields, 39 to 48 bushels; range of yields in 1893, 16 to 24 bushels, being greatly reduced by the dry weather; highest average yield produced from stalks eleven inches apart; lowest average yield produced from stalks twenty inches apart. The variety of corn used in these experiments is a rather small yellow dent, which matures in this latitude the first of September.

III. EXPERIMENTS WITH EARLY AND LATE SOWING AND PLANTING.

1. *Wheat.*—Range of dates, September 18 to October 18; time under trial, five years; range of average yields, 20 to 31 bushels; average yield from earliest sowing, 31 bushels; average yield from latest sowing, 20 bushels.

2. *Corn.*—Range of dates, May 1 to May 29; time under trial, five years; range of average yields, 36 to 47 bushels; average yield of earliest planting, 47 bushels; average yield of latest planting, 36 bushels; the yields were considerably reduced by the poor crop of 1893, which was less than half of an average crop.

IV. EXPERIMENTS WITH DEEP AND SHALLOW PLOWING FOR CORN.

This experiment has been continued for three successive years, corn being the crop grown. Different depths of plowing, four, six, eight, ten and twelve inches; range of average yields, 40 to 44 bushels; highest average yield from plowing eight inches deep; lowest average yield from plowing four inches deep. The averages given above are of course greatly reduced by the low yield of 1893.

V. EXPERIMENTS WITH DEEP AND SHALLOW CULTIVATION OF CORN.

Different depths of cultivation, one, two and three inches; time under trial, five years. Average yields from cultivation one inch deep, 51 bushels; average yields from cultivation two inches deep, 50 bushels; average yields from cultivation three inches deep, 49 bushels. The poor crop of 1893 greatly reduced the average yields given above.

VI. EXPERIMENTS WITH DIFFERENT CORN CULTIVATORS.

Number of implements tested in 1893, six; time under trial, two to six years; five distinct types of cultivators were used, namely: The common two-horse plow, with two shovels in each gang; the spring-tooth cultivator, with six teeth in each gang; the Gopher (two forms), which merely shaves below the surface and tends to draw the earth towards the corn; disc corn plow, which has a strong tendency to deep cultivation and ridging of the ground; adjustable one-horse cultivator, with leveling attachment following shovels. The experiment was conducted in a very elaborate form in 1893, with the view of securing the best possible conditions in the test for each implement used. The excessive drouth and an accident practically ruined all of the plats, so that no results of value could be secured for 1893. The average yields of corn, not including 1893, were as follows: With corn plow, average of five years, 55 bushels; with spring tooth cultivator, average of five years, 57 bushels; with Gopher (Hoosier), average of five years, 57 bushels; with Gopher (Tower's), one year, 61 bushels; with disc cultivator, average of two years, 59 bushels; with adjustable cultivator, average of two years, 61 bushels.

VII. EXPERIMENT TO DETERMINE THE LASTING EFFECT OF MANURE ON YIELD OF CORN.

This experiment was begun in 1883 on a dark compact loam which has been producing corn continuously since 1880. Fresh horse manure was applied to a series of plats in 1883 and 1884, amounting, for the two years, to about fifty tons per acre. Gas lime was applied the same years on another series of plats. To a third series of plats super-phosphate was applied the same years as above. The aggregate amounts of gas

lime and super-phosphate applied were five hundred pounds per acre. The above-named years are the only ones in which any manure or fertilizer has been used. Eleven crops have been grown since the first application of fertilizers and manure. The crops of 1887 and 1893 were almost complete failures, owing to severe drouths. The crop of 1887 is not included in getting the figures which follow. The gas lime and super-phosphate have been practically without effect on the yields of corn. The average increase in yield of corn produced by the horse manure is 11 bushels per acre; the aggregate increase of the ten crops produced by the manure is 113 bushels per acre. Notwithstanding the severe drouth in 1893, which doubtless reduced, to some extent, the effect of the manure, the increase from this cause was 3½ bushels per acre.

VIII. EXPERIMENTS WITH ROTATIVE CROPPING AND CONTINUOUS GRAIN GROWING WITHOUT MANURING.

Since 1880 corn, oats and wheat have been grown continuously, or alternately, on series H. The same grains, in connection with beans, roots and grass, have been grown in rotation on series F. The two series of plats lie side by side with soil apparently similar. The entire crop has been harvested and removed in every case. The average yields of staple grains for the last five years are as follows: Series H, on which the grains are grown continuously or in alternation, corn, 27 bushels, oats, 24 bushels, wheat, 15 bushels; series F, in which the same crops, with the others named, are grown in rotation, corn, 32 bushels, oats, 32 bushels, wheat, 22 bushels; average gain per acre from rotative cropping, corn, 5 bushels, oats, 8 bushels, wheat, 7 bushels; average per cent. gained from rotative cropping over continuous grain growing, corn, 19 per cent., oats, 33 per cent., wheat, 47 per cent.

IX. EXPERIMENTS WITH HEAVY AND LIGHT APPLICATIONS OF MANURE AND FERTILIZER.

This series of experiments was begun in 1889. Applications of fertilizer and manure were made in 1890 and succeeding years. Fresh horse manure and high grade commercial goods have been used in these experiments. The average increase in

yield per acre, from fertilization and manuring, has been, for the several grain crops, as follows:

Amount and Kind of Fertilization.	Barley.	Corn.	Oats.	Wheat.
Heavy applications of fertilizers......	12.3	8.7	4.5	7.5
Light applications of fertilizers.......	9.1	10.9	3.8	6.5
Heavy applications of manure.......	8.2	11.0	11.0	6.5
Light applications of manure........	8.6	10.3	8.2	5.4

X. Experiments with Complete and Partial Fertilizers and Manures.

This experiment was begun in 1889, although the first application of fertilizer and manure was in 1890. The crops of 1892 and 1893 were grass, which, according to the plan adopted, received no fertilizer or manure. It follows, therefore, that but two crops—oats in 1890, and wheat in 1891—have received the applications of fertilizer and manure. The grass crop of 1892 was almost a complete failure in this series of experiments owing to the "poor catch." The plats were re-seeded and a fair stand secured, but the drouth of 1893 reduced the yield more than half. The results are as follows:

	Oats.	*Wheat.*	*Grass.*
Average increase in yield per acre from complete fertilization................	5.0 bu.	*2.7 bu.	*767 lbs.
Average increase in yield per acre from partial fertilization................	3.0 bu.	*1.3 bu.	*57 lbs.

The anomalous results with wheat and grass are doubtless due (1) to too rank growth of wheat and (2) to consequent poorer catch of grass on the fertilized plats.

XI. Experiment to Determine Effect of Spring Mowing of Wheat upon Yield of Crop.

The purpose of this experiment is to determine whether mowing the crop in spring just before jointing will, by preventing undue rankness of growth, serve to increase the yield of crop. The experiment has been conducted two years. The results are as follows:

*Loss.

Average yield mown plats	19.09 bushels
Average yield plats not mown	24.11 bushels
Average loss from mowing	5.02 bushels

In both years the growth of the plats not mown was not very rank, hence the loss from mowing is only what might be expected.

XII. IMPROVEMENT OF CORN BY SELECTION AND CARE.

This experiment was undertaken in the spring of 1893. A typical ear of medium-sized Yellow Dent corn, which has been grown at the Station for a number of years, was selected for the test. The corn was planted in a suitable soil remote from other corn plats. The preparation of the ground and cultivation of the crop were in accord with improved methods of farming. From time to time the plat was visited and all stalks showing any imperfections or any development of smut were removed before tasseling. Only perfect stalks which produced, or gave promise of ears were permitted to remain. Owing to the intensity of the drouth no perfect ears were developed on the plat. At husking time ears were selected from the most perfect of the plants and from these, seed for 1894 will be obtained. It is the intention to continue this experiment. It is believed by the method employed that the corn can be rendered more uniform and improved in some respects. It will, however, doubtless take several years to effect any marked results.

XIII. RELATION OF EARLY AND LATE PLANTING OF CORN TO LENGTH OF TIME REQUIRED TO MATURE THE CROP.

This experiment was begun in 1892. Both 1892 and 1893 were abnormally dry in the late summer. As a result, in every case there was premature drying of the different varieties, and with the most careful daily observation it was practically impossible to determine the actual time of maturity. The results obtained are therefore doubtless only rough approximations to the exact truth. Three varieties, differing a week to ten days in the time of ripening, were planted at each of the dates indicated below. The figures given below show the average number of days, for the two years, required to mature the three varieties at each of the dates of planting.

	1892.	1893.	Days to Mature—Average Two Years.
Planted	. . . . . .	May 6. . .	122
Planted	. . . . . .	May 16 . .	117
Planted	May 24 . .	May 27 . .	112
Planted	June 4. . .	June 6. . .	109
Planted	June 14 . .	June 16 . .	107

Several lines of experiment referred to above must of necessity be continued for a number of years before reliable and satisfactory conclusions can be reached.

Respectfully submitted,

W. C. LATTA,

Agriculturist.

The Agricultural Experiment Station of Indiana in Account with the United States, for the Year Ending June 30, 1893.

DEBIT.		
Appropriation		$15,000 00
CREDIT.		
Repairs	$154 66	
Improvements	430 80	
Printing, stationery and bulletins	724 11	
Books and periodicals	198 76	
Care of buildings	427 50	
Postage	46 73	
Insurance	67 60	
Live stock	162 00	
Gas	70 80	
Traveling expenses	71 25	
Advertising	32 64	
Supplies	1,412 74	
Salaries	7,850 00	
Labor	3,054 38	
Apparatus and fixtures	104 87	
Express, freight and hauling	181 16	
Miscellaneous	10 00	
Total		15,000 00

The above is a correct statement of the General Fund of the Agricultural Experiment Station of Indiana for the year ending June 30, 1893.

E. A. ELLSWORTH,
Secretary Board of Trustees.

Improvement Fund Experiment Farm for Year Ending June 30, 1893.

DEBITS.		
Balance unexpended June 30, 1892	$907 79	
Receipts from farm	1,487 49	
Total		$2,395 28
CREDITS.		
Insurance	$50 00	
Labor	330 00	
Live stock	180 00	
Improvements	131 09	
Supplies	158 50	
Salary	194 52	
Printing and stationery	87 50	
Balance unexpended	1,263 67	
Total		$2,395 28

The above is a correct statement of the Improvement Fund for year ending June 30, 1893.

E. A. ELLSWORTH,
Secretary Board of Trustees.

PURDUE UNIVERSITY

SEVENTH ANNUAL REPORT

OF THE

Agricultural Experiment Station

LAFAYETTE, IND.

1894

INDIANAPOLIS:
[illegible]BFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.
1895.

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PURDUE UNIVERSITY

SEVENTH ANNUAL REPORT

OF THE

Agricultural Experiment Station

LAFAYETTE, IND.

1894

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.
1895.

PURDUE UNIVERSITY.

SEVENTH ANNUAL REPORT

OF THE

Agricultural Experiment Station,

LAFAYETTE, IND.

1894.

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.
1895.

STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
INDIANAPOLIS, February 2, 1895.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

FEBRUARY 2, 1895.

Transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

MYRON D. KING,
Private Secretary.

Filed in the office of the Secretary of State of the State of Indiana, February 4, 1895.

W. D. OWEN,
Secretary of State.

Received the within report and delivered to the printer.

J. B. MAYNARD,
Clerk Printing Bureau.

To the Governor:

I herewith transmit the annual report of the Purdue University Agricultural Experiment Station, due February 1, 1895.

Very respectfully,

C. B. STUART,
President Board of Trustees.

January 30, 1895.

To the President of the Board of Trustees:

I herewith present the annual report of the Agricultural Experiment Station of Indiana, due on or before the 1st of February, 1895, the same being required by section 3 of an act entitled "An act to establish agricultural experiment stations in connection with the colleges established in the several States, under provisions of an act approved July 2, 1862, and of the acts supplementary thereto."

This report consists of a report of the director of the Station, and the financial report of the Secretary to the Board of Trustees.

Respectfully submitted,

J. H. SMART,
President.

PURDUE UNIVERSITY, LAFAYETTE, IND., January 30, 1895.

BOARD OF CONTROL.

Charles B. Stuart, President .... LaFayette
William A. Banks .... LaPorte
Jasper N. Davidson .... Whitesville
Sylvester Johnson .... Irvington
David E. Beem .... Spencer
Job. H. Van Natta .... Battle Ground

JAMES H. SMART, LL.D.,
President of the University.

EDWARD A. ELLSWORTH,
Secretary.

JAMES M. FOWLER,
Treasurer.

STATION STAFF.

Charles S. Plumb, B. S ....Director
William C. Latta, M. S.....................................Agriculturist
James Troop, M. S ....Horticulturist
Henry A. Huston, A. M., A. C ....Chemist
Joseph C. Arthur, D. Sc ....Botanist
Arville W. Bitting, B. S ....Veterinarian
George R. Ives, B. S ....Ass't Agriculturist
William Stuart, B. S ....Ass't Botanist
Jesse M. Barrett, B. S......................................Ass't Chemist

SEVENTH ANNUAL REPORT

—OF THE—

Purdue University Agricultural Experiment Station.

REPORT OF THE DIRECTOR.

To President James H. Smart:

Sir—I have the honor to herewith transmit to you the seventh annual report of the Purdue University Agricultural Experiment Station, for the year 1894.

The *Station Staff* has undergone no change, excepting in the positions of assistants. Mr. William Brady, who was temporarily acting as Assistant Chemist, returned to the position he had occupied prior to coming here, and on July 15, Mr. J. M. Barrett, a graduate of the Class of 1894 in the School of Agriculture of Purdue, was appointed to the vacancy. Mr. S. Grant Wright, the Assistant Botanist, resigned on July 1, and Mr. William Stuart, a graduate of the School of Agriculture of Vermont University, was appointed to the vacancy thus created. These changes have necessitated no interruption in the work of the departments.

Experimental work as a whole has been conducted on the same lines as for several years past. New work, however, has been accomplished in several of the departments, that is noteworthy in character, and will be referred to later on in my

report, as well as by members of the Staff contributing to this document.

In the Chemical Department the sugar beet studies have occupied considerable attention. Over ninety sub-stations grew beets in different parts of the State under the direction of this department, and by the end of the season a larger number of samples had been sent in for analysis than ever before in one year. The results of this work were gratifying, and it is believed that enough data has already been secured to warrant the conclusion that sugar beets may be profitably grown for sugar in Indiana. Commendable interest has been taken in the work by many farmers of the State, and some have volunteered to grow acre tracts for parties who would furnish free seed for the purpose. It is reasonable to assume that, if the United States are to produce enough sugar for home consumption, the sugar beet will be the most important factor in accomplishing this. In this case, it may reasonably be expected that Indiana will be classed among the sugar producing States.

One of the legitimate functions of a laboratory is the development of superior methods of investigation, or the production of apparatus of improved character and utility. The past year two important laboratory appliances have been designed by the Chemist. One of these is for the purpose of constantly agitating the contents of flasks by mechanical action, a class of work usually done by hand, thus employing much of the valuable time of the laboratory worker. This machine is a wheel, to which a number of flasks are fastened, which is submerged and may be constantly revolved in water of a given temperature, by means of an electric motor. The other piece of apparatus consists of a series of glass stirrers which move in unison and stir the contents of a number of beakers into which they project. This invention is also of more than ordinary interest, as it saves much laboratory work and also tends to aid in producing uniformity of results. A bulletin will be issued early in 1895 describing and illustrating this apparatus and its work.

The study of the unproductive soils of the State has been continued in both laboratory and field, and the influence of nitrogen in various forms on the wheat plant is also receiving attention. Some experimental work was conducted by the Chemist at the stables during the year, to note the influence of

digestion on crude fibre and lignin, but the laboratory analyses are not yet completed.

In the Veterinary Department, among other investigations, those of especial moment were on tuberculosis and swine plague. A large part of the University herd was inoculated with tuberculin as a diagnostic agent in tuberculosis, but the herd, as far as tested, did not respond. Further work will be continued in this direction.

During the latter part of 1894 many western pigs were brought to Indiana for feeding. The introduction of this stock was attended with the occurrence of swine plague in various parts of the State, and one severe outbreak occurred in the city of La Fayette. The prevalence of the disease here gave opportunity for the Veterinarian to make a study of the malady and secure important information on the subject.

Notwithstanding the limited funds at his command, the Veterinarian has prepared much material for future study, and has notably improved the illustrative equipment of the department. Quite an extensive amount of material illustrative of animal parasites has been collected to be used in future studies of these pests.

For the past two years this locality has suffered from dry weather to such an extent as to seriously interfere with the successful growing of crops, and notably corn and those plants which mature in August or September. In 1893 the drought was excessive, while in 1894 the corn crop on the Station grounds fell far short of being what it probably would have been had the supply of moisture been sufficient.

In the Horticultural Department, for the first time, something of a study of Russian fruits has been made possible by the ripening of some of these. Nothing extensive has been attempted in the way of variety tests in the garden. Experiments have been made to prevent the destruction of fruits by birds on small trees by covering them with netting; to prevent scab in the potato by the use of arsenic preparations; and comparing the yields of onions grown from home and foreign seed.

The work of the Agriculturist, of which an abstract is given in this report, has been along much the same lines as for some years. One valuable addition to the work of this officer has been in securing the co-operation of a number of persons to

grow experimental corn and wheats under his direction in different parts of the State. The experiments are also conducted at the home station, so that the same work in a measure is carried on in five parts of Indiana. Useful practical tests of varieties or comparing influences of manures and fertilizers on crops may be carried on by this co-operation, thus giving the Station access to a range of soil and other conditions not available at the University.

In the Botanical Department, the field work with the potato in reference to relationship of seed tubers to crop, has been continued, but will not be continued to any considerable extent another season. The general results of this experiment will be published in a bulletin in 1895. Potato studies, however, will be conducted to a limited extent, and particularly in relation to the scab and methods of prevention.

The subject of sub-irrigation is receiving some attention in this department, both in the open ground and the greenhouse. As the work was begun this season, no results of significance are worthy of note here.

The glass vegetation house erected in 1893 for pot culture experiments has been in active use during the season. A series of tracks extend from within the house to forty feet outside, on which are placed trucks carrying plants, growing in large metal pots. These trucks can be wheeled back and forth, so that a number of pots containing growing crops may be fully exposed to the weather and yet protected from winds and rain by running the trucks into the house if necessary. Where plants are thus grown in pots, certain conditions of moisture and plant food can be controlled, and a class of observations taken, that can not be accurately measured if the plant is growing in the open ground. Elementary experiments were conducted during the year with corn, oats, wheat, buckwheat, potatoes and purslane, and interesting results secured. This work promises one of the most valuable lines of research in the Botanical Department, and is a field as yet but slightly touched by the American Experiment Station.

No investigation has been conducted in the Dairy during 1894, further than milk testing in connection with feeding experiments. This is due to the fact that no assistant has been available, who was especially adapted to this class of work. Three feeding experiments have been carried on, one

extending over the entire year, involving a test of six of the cows of the herd, including amount and cost of food eaten, milk produced and its value as based on butter fat content. Various experiments upon methods of raising calves have been in progress during 1894, and will be continued during the next year. A comparative feeding trial of wether lambs, one lot fed corn, and the other wheat, was also conducted. All of the feeding work was along lines taken up in 1893.

No *permanent improvements* have been made this year, outside of fencing. The north and west sides of the farm north of the University campus has been fenced, and a new board fence has been erected on the north side of the pasture west of the experimental plats.

Improvements to facilitate experimental work should be made in three departments in particular. Although well equipped, the chemical laboratory is most inconveniently arranged, and greatly limited in available working room. For a comparatively small sum, the brick L extending out from the southeast corner of the station building could be made into a model laboratory.

The Veterinary Department consists in the main of an office, a small laboratory room and a hospital building. The latter is used for both students and investigation work, but is not suitable for the present demands upon it. There is no place that can be classed as an operating room, neither is the building suitably planned to admit of satisfactory experimental work in animal diseases, especially with those where immunity is desirable or necessary. For five thousand dollars it is believed that a veterinary building could be erected that would be well adapted to investigations and instruction.

An important adjunct to a Horticultural Department is a propagating house and green house. This department has an office and an experimental grounds of ten acres, but there are no facilities whatever for winter work, outside of that provided in the library and office. If one thousand dollars could be placed available to this department for a propagating house, it would materially improve the facilities for work.

If means could be provided through legislative action for making the above designated improvements, the three departments in question would be greatly strengthened in working facilities.

The publications of the Station during the year have consisted of one annual report, two newspaper bulletins and six regular bulletins. These are as follows:

Sixth annual report for the year 1893, pp. 34.

Bulletin No. 48, vol. V, January, 1894, pp. 16. Experiments with Small Fruits.

Bulletin No. 49, vol. V, March, 1894, pp. 17–42. Sugar Beets.

Bulletin No. 50, vol. V, April, 1894, pp. 43–56. Field Experiments with Corn and Oats.

Bulletin No. 51, vol. V, August, 1894, pp. 57–80. 1. Field Experiments with Wheat. 2. Forms of Nitrogen for Wheat.

Bulletin No. 52, vol. V, November, 1894, pp. 81–112, plates IV. Wild or Prickly Lettuce.

Bulletin No. 53, vol. V, December, 1894, pp. 113–130, plates IV. Fig. 1. Horticulture and Entomology.

Newspaper Bulletin No. 6, May 9, 1894, p. 4. A Substitute for Coffee.

Newspaper Bulletin No. 7, June 14, 1894, p. 1. An Objectionable Food Preservative.

The demands for the bulletins have constantly increased, and the mailing list is rapidly growing larger. Below is the list showing its growth during the past two years:

STATION MAILING LIST.

Number of Names on List of	Jan. 18, 1893.	Jan. 4, 1894.	Jan. 10, 1895.
People in Indiana	5,741	7,131	8,666
Indiana periodicals	635	668	653
People in other States	1,158	1,316	1,606
Periodicals in other States . .	83	91	86
Foreigners	26	51	61
Foreign periodicals	7	7	7
Total.	7,650	9,264	11,079

Bulletin 53 was an edition of 11,500 copies, but at the rate the demand for bulletins is growing, much larger editions will have to be printed before the end of another year. The growing demand for the bulletins is very largely from private solicitation for them through the mail, and to a certain extent through lists of addresses sent in by individuals who are impressed with the importance of the work being accomplished.

Gifts of considerable value have been received from various sources during the year, and I take pleasure in hereby acknowledging them with thanks.

MISCELLANEOUS GIFTS.

United States Department of Agriculture, Washington, D. C. Numerous packets of seed, books, pamphlets, etc.

S. Hoxie, Secretary, Vols. I to IV, Advanced Registry, Holstein-Friesian Cattle Association of America.

Italo Giglioli, Portici, Italy. Numerous books and pamphlets.

Wisconsin Agricultural Experiment Station, Madison. Vol. I, Victoria Swine Record; Vol. II, American Merino Sheep Record; Vol. III, English Guernsey Herd Book.

W. Atlee Burpee & Co., Philadelphia, Pa. 33 sample packets of seed.

L. P. Sisson, Secretary, Wheeling, W. Va. Vols. I–V of American Devon Record.

J. H. Sanders, Chicago. Ill. Vols. II and III, Percheron Stud Book.

German Kali Works, New York City. Numerous pamphlets and German potash salts.

Gen. Cassius M. Clay, Whitehall, Ky. Pair Southdown sheep.

Mrs. V. C. Meredith, Cambridge City, Ind. Monograph on the live stock of the State of Indiana.

Edward Norton, Secretary, Farmington, Conn. Vols. I, III and IV of the American Guernsey Herd Book.

William R. Session, Secretary, Boston, Mass. Index of reports Massachusetts State Board of Agriculture 1837–1892; also annual report for 1894.

Dr. J. A. Lintner, State Entomologist, Albany, N. Y. Eighth and ninth annual reports on injurious and other insects of the State of New York.

Office of Experiment Stations, Washington, D. C. Sugar beet seed.

J. McLain Smith, Secretary, Dayton, Ohio. Vol. V, Red Polled Herd Book.

P. M. Sharples, West Chester, Pa.; DeLaval Separator Co., Elgin, Ill.; Vermont Farm Machine Co., Bellows Falls, Vt. Loans of separators.

The Deming Co., Salem, Ohio. 1 Success spray pump, with attachments.

E. F. Diehl, Leesburg; S. W. Dungan, Franklin; James Riley, Thorntown; A. W. Bewsey, Colfax; N. J. Fleming, Tabor; J. C. Stevens, Centreville; J. A. Mount, Shannondale; Riley Sanders, Bloomington; T. J. Groves, Dana; B. F. Smith, Muncie; Cal Husselman, Auburn; W. W. Stevens, Salem; J. M. Branson, Farmland; J. W. Wile, Thorntown; J. E. Reyman and W. B. Lindley, Salem; John Bazner, Bunker Hill. Seed corn.

J. A. Everitt, Indianapolis, Ind. Seeds.

Kansas State Horticultural Society. Third biennal report for 1891-93.

Alfred Mansell & Co., Secretary, Shrewsbury, England. Vols. I to XII inclusive. Shropshire Flock Book of England.

Lane & Goodwin, LaFayette, Ind. Set photographs of Purdue dairy.

Oakleigh Thorne, Millbrook, N. Y. Photographs of Thorndale Stock Farm sheep barn.

Catesby Woodford, Paris, Ky. Jersey bull calf, St. Lambert Purdue, 37156 A. J. C. C.

Henry Heil Chemical Co., St. Louis, Mo. 1 Acme milk tester.

Prof. C. C. Georgeson, Manhattan, Kan. 3 bags soy beans.

Department of Agriculture, Queensland, Australia. Annual report of Department, 1892–93, and bulletins.

Wilbur Aldrich & Co., New York. "Farming Co-operations."

Robert Manning, Sec., Boston, Mass. Trans. of Mass. Horticultural Society, I, II, 1893.

Thos. Sturgis, Secretary, New York City. "Proceedings of the New York Farmers, 1893–1894."

Dr. F. W. Dafert. Director, Campinas, Brazil. Annual Report of the Agricultural Institute of the State of São Paulo, for 1893.

Ontario (Can.) Department of Agriculture, Toronto, Canada. Numerous agricultural books and pamphlets.

Agricultural Bureau, Tokyo, Japan. Catalogue of agricultural products of Japan exhibited at World's Columbian Exposition, 1893.

Jamaica World's Fair Commissioner, Chicago. "Jamaica at the World's Fair."

Dr. Horace W. Hopkins, D. V. S. Proc. U. S. Vet. Med. Assn. Sessions, 1891–92.

Bureau of Commerce and Industry of Japan, Tokyo. "General View of Commerce and Industry in Empire of Japan."

Angus Mackay, Australia. "Elements of Australian Agriculture."

C. F. Kennedy, Sec., Indianapolis, Ind. Annual reports State Board of Agriculture, 1892, 1893.

George W. Rafter, Rochester, N. Y. Report on Genesee River Storage.

Dr. N. D. Gaddy, Lovett, Ind. ½ bushel winter oats.

T. W. Kirk, New Zealand. Second report of the Department of Agriculture of New Zealand.

U. S. National Museum, Washington, D. C. Vol. 16, Proceedings of the U. S. National Museum. Report Smithsonian Institute.

W. S. Moffatt, Chicago, Ill. Botanican specimens.

Mortimer Levering, LaFayette, Ind. Jersey bull calf.

Thos. Whitehead, Sec., Richmond, Va. Report Virginia State Board of Agriculture for 1894.

F. D. Coburn, Sec., Topeka, Kan. Reports on "Alfalfa" and "Feeding Wheat."

Thos. Luchsinger, Commissioner, Madison, Wis. Annual Report of the Dairy and Food Commissioner of Wisconsin, for 1893.

White River Jersey Cattle Club, Muncie, Ind. Jersey heifer, "Edgewood Queen," 86,662 A. J. C. C.

Academy of Science, Indianapolis, Ind. Proceedings of the Academy of Science for 1893.

F. L. Houghton, Sec., Brattleboro, Vt. Vol. 12, Holstein-Friesian herd book.

W. H. Caldwell, Sec., Peterboro, New Hampshire. Vols. I and V, herd register American Guernsey Cattle Club.

Wisconsin Experiment Station, Madison. Photograph of Russian thistle.

DeLaval Separator Co., Elgin, Ill. One bowl wrench.

M. A. Cooper, Sec., Washington, Pa. Vols. I–II, Flock Record, Dorset Horn Sheep in America.

George F. Davis, Sec., Dyer, Ind. Vols. I–II, Victoria Swine Record.

G. Howard Davidson, Millbrook, N. Y., engravings.

Robbins & Sons, Horace, Ind., engravings.

T. S. Moberly, Richmond, Ky., engravings.

Charles F. Mills, Sec., Springfield, Ill., 1894 year book American Berkshire Association.

Jackson & Perkins, Newark, N. Y., 1 dozen strawberry plants.

J. H. Fulton, Sec., Nashville, Tenn., Vol. I American Jack Stock Stud Book.

Handy Washer Co., Muncie, Ind., 1 Centrifugal butter worker.

E. Sudendorf, Agent, Elgin, Ill., 1 quart Wells & Richardson Improved butter color.

Carl Friegau, Sec., Dayton, Ohio, Vol. XVI Ohio Poland China Record.

L. B. Wombwell, Commissioner, Jacksonville, Report Florida State Horticultural Society, 1894.

Louden Machinery Co., Fairfield, Ia., 1 hay sling.

J. T. Bentley, Circleville, Ohio, 1 copy "Bentley's Lightning Calculator."

PERIODICALS.

Agricultural Gazette of New South Wales	Sidney, Australia.
Agricultural Epitomist	Indianapolis.
American Agriculturist	New York City.
Agricultural Globe	Montrose, Pa.
American Bee Journal	Chicago, Ill.
American Cultivator and Poultry Keeper	Los Angeles, Cal.
American Fertilizer	Philadelphia, Pa.
American Florist	Chicago, Ill.
American Grange Bulletin	Cincinnati, Ohio.
American Sheep Breeder and Wool Grower	Chicago, Ill.
Baltimore Sun (weekly)	Baltimore, Md.
Breeder's Gazette	Chicago, Ill.
Clover Leaf	South Bend.
Creamery Journal	Waterloo, Ia.
Drainage Journal	Indianapolis.
Elgin Dairy Report	Elgin, Ill.
Experiment Station Record	Washington, D. C.
Farm and Dairy	Ames, Ia.
Farm and Fireside	Springfield, Ohio.
Farm and Home	Chicago Ill.
Farm, Field and Fireside	Chicago, Ill.
Farm Journal	Philadelphia, Pa.
Farm Poultry	Boston, Mass.
Farmer's Advocate	London, Ontario, Can.
Farmer's Call	Quincy, Ill.
Farmer's Guide and Home Companion	Huntington, Ind.
Farmer's Home	Dayton, Ohio.
Farmer's Review	Chicago, Ill.
Good Roads	New York City.
Grange Visitor	Lansing, Mich.
Hoard's Dairyman	Ft. Atkinson, Wis.
Holstein-Friesian Register	Brattleboro, Vt.
Home and Farm	Louisville. Ky.
Home Journal	LaFayette.

Hospodar	Omaha, Neb.
Indiana Farmer	Indianapolis.
Industrial American	Lexington, Ky.
Industrialist	Manhattan, Kan.
Insect Life	Washington, D. C.
Jersey Bulletin	Indianapolis, Ind.
Journal of Agriculture	St. Louis, Mo.
Journal of Mycology	Washington, D. C.
Kansas Farmer	Topeka, Kan.
LaFayette Commercial Gazette	Lafayette.
Louisiana Planter and Sugar Manufacturer	New Orleans, La.
Mennonitische Rundschau	Elkhart.
Michigan Farmer	Detroit, Mich.
Mirror and Farmer	Manchester, N. H.
National Dairyman	Kansas City, Mo.
National Stockman and Farmer	Pittsburgh, Pa.
Nebraska Farmer	Lincoln, Neb.
New England Farmer	Boston, Mass.
Ohio Farmer	Cleveland, Ohio.
Orange Judd Farmer	Chicago, Ill.
Pacific Rural Press	San Francisco, Cal.
Practical Farmer	Philadelphia, Pa.
Prime's Crop Bulletin	Dwight, Ill.
Progressive South	Richmond, Va.
Rural Northwest	Portland, Ore.
Southern Cultivator and Dixie Farmer	Atlanta, Ga.
Success with Flowers	West Grove, Pa.
Sugar Beet	Philadelphia, Pa.
Wayne Farmer	Hagerstown.
Western Swineherd	Geneseo, Ill.
Wisconsin Agriculturist	Racine, Wis.

For the past four years it has been customary to publish newspaper bulletins at such times as it might seem desirable. These contained information of a serviceable character, and their contents have been very largely published by the papers of Indiana, as well as many published outside of the State. In order, however, to make the contents of these newspaper bulletins available to a certain class who will not get them otherwise, they are republished as an appendix to this annual report.

I herewith submit the annual reports of the several departments of the Station, as a part of this, the annual report of the experiment Station for 1894.

Respectfully submitted,

C. S. PLUMB,

Director.

REPORT OF THE CHEMICAL DEPARTMENT.

To C. S. Plumb, Director:

SIR—The following is a summary of the work of the Chemical Department for the year 1894:

SUGAR BEETS.

The experimental work on sugar beets begun at the Station in 1888 has been continued. In addition to the work on the Station farm seed was sent to 95 stations in various parts of the State where farmers desired to coöperate with the Station in working on this subject. Forty-eight of these stations sent reports and nearly all the others reported satisfactory reasons for failure to send samples. This is by far the best showing ever made in the coöperative work. The season was fairly favorable to the crop in some sections of the State, while in other sections the severe drought seriously interfered with the work. The results will be published in full in a bulletin on the subject. In general the results are such as to lead to the belief that so far as the agricultural side of the question is concerned the sugar beet industry would be a profitable one in the State.

This year, in addition to the usual tests of small plats, a number of workers experimented on larger areas with a view of determining the cost of raising the beets on a commercial scale. The results of these tests were satisfactory.

This coöperative work has made a large number of farmers in different parts of the State familiar with the conditions required for raising sugar beets, and should the commercial situation of sugar warrant the investment of capital in the enterprise the work already done will give Indiana a considerable advantage in competing for the location of factories.

An incidental advantage derived from this coöperative work is found in the fact that the farmers' attention has been drawn to the high feeding value of the beet for stock, and many farmers have decided to raise the beets for stock feed.

Unproductive Soil.

Observations on the unproductive soil to which various substances were tried in 1892 have been continued. The soils still show a high increase in productiveness on the plats to which straw or kainit was applied. No further treatment of the plats was made this year as the owner of the property could not make the necessary changes in the drainage. The results obtained on this land have already proven of value in dealing with similar lands in other localities. As this class of land occurs in many localities and many fields contain small areas of unproductive soil in the midst of good farming land, any treatment that will make these small areas productive at moderate expense is of much agricultural importance.

Forms of Nitrogen for Wheat.

This work was continued along the same lines as in previous years. The rust again seriously interfered with the work. The experiment is still in progress.

Phosphates for Corn.

This work has been abandoned on the Station farm, since drought so frequently injures our corn and our land is of such a character as to give very little return from the use of phosphatic manures. A sub-station situated on clay land low in available phosphates, is much needed for this work in phosphates. The expenditures of farmers for phosphatic manures are high, and increasing every year. So great a variety of phosphatic material is on the market, with such a wide range in price, that carefully conducted experiments on suitable soil promise to yield results of much practical benefit.

Special Work on Phosphates.

Work on this subject was carried on during the early part of the year. A great variety of phosphates, both natural and superphosphates, were examined, and it is believed that the results of the work have added a useful method to those already tried for the purpose of detecting adulteration of basic slag, and for the purpose of finding the origin of the phosphate used in the manufacture of superphosphates.

Crude Fibre.

Work on this subject has been continued, extending the work to a comparison of the crude fibre in hay and in manure produced by cattle fed on the hay. The various extracts made in producing the fibre, also furnish material that is made use of in studying the subject of carbohydrates in feeding material.

MARLS.

A number of marls from different parts of the State have been examined. Large beds of this substance exist in various parts of the State and the material is of much value on either very heavy or very light soils. Those examined contained a very large percentage of carbonate of lime in fine mechanical condition, and in some a small amount of nitrogen was present. Phosphoric acid was not found in any of them. These marls would be useful for mechanical improvement of many soils and for furnishing the lime necessary for nitrification in those soils which are relatively low in lime.

Sub-Soils.

In certain sections of the State, farmers are using the dark-red clay which forms the sub-soil, to spread on the surface of the white clays, which form the surface soil. Several reports give encouraging results from this work. One such sub-soil has be examined in the laboratory, and work will be done on another sample which has been received.

Special Apparatus.

Several pieces of special apparatus for agricultural analysis have been designed and constructed during the year. The results are very satisfactory and will appear in a technical bulletin now in preparation. The machines are designed to do much of the work now done by hand and in addition to saving much time, are useful in removing one or more of the varying conditions incident to some of the empirical methods used in analysis and so rendering work done by such machines more comparable than that done under conditions subject to greater variations due to differences in manipulation.

Food Preservatives.

Work is in progress on a large number of food materials to detect the presence of objectionable food preservatives. A newspaper bulletin on this subject awakened considerable interest and was widely copied in other States. If objectionable substances are used for food preservatives, the purchaser ought to be informed of the fact before purchasing the food, when such substances are offered for sale.

Correspondence.

The correspondence of this department is increasing every year and represents no inconsiderable amount of work. The questions on which farmers wish information are various, and their full answers often require considerable investigation. The character of the matter involved in this correspondence is quite different from what it was a few years ago and indicates that farmers are directing attention to subjects of fundamental importance in their work.

Equipment.

The equipment of the laboratory has been well maintained, but the department is hampered by its limited quarters, which prevent the best use being made of the valuable material which is provided for the use of the department.

During four and one-half months the department was without the service of an Assistant Chemist, Mr. William Brady,

who was temporarily employed, leaving on March 1. His place was supplied late in July by Mr. J. M. Barrett. The services of both these gentlemen have been highly satisfactory.

Miscellaneous.

The usual amount of work for various departments of the Station has been done and many examinations, qualitative and quantitative, have been made of material sent to the Station.

Very respectfully submitted,

H. A. HUSTON,

Chemist.

REPORT OF THE BOTANICAL DEPARTMENT.

To C. S. Plumb, Director:

SIR—The work in the Botanical Department during the year 1894 has been mainly along three lines: (1) the study of certain physiological problems relating to the planting and care of potatoes, carried on largely in the field, continued from former years; (2) the investigation of the food and water requirements of plants, begun this season, and carried on largely in the vegetation house recently built for the purpose; and (3) the examination of the question of weeds, especially of recent arrivals in the State. Many other matters received some attention, but none to the extent of those named.

POTATOES.

The field experiments with potatoes embraced such problems as the following: What is an economical use of seed potatoes? In regard to the use of hills or drills the trials of former years have shown that the latter method under most circumstances is preferable. This year trial was made of the use of a certain amount of seed material in each row (equivalent to using a certain number of bushels per acre) but distributing it differently. Thus in one set of trials whole potatoes were taken, assorted into lots according to size. To use the same quantity of seed in each row the tubers were placed closer together in the drill the smaller they were, but only one in a place. The smallest sized tubers used weighed an average of one ounce each, and the largest three ounces each. The results showed an unexpectedly large increase in yield from the smaller seed tubers, both in total yield and in yield of merchantable potatoes. Putting this into every day phraseology, it means that when whole potatoes are planted, evenly distributed, one by

one in the drill, the same amount of seed per acre will yield better results, within certain limits, the smaller the seed tubers that are used. A trial of the same nature, except that each potato was cut into two pieces before planting, gave less satisfactory results, owing to the failure of many of the cut pieces to grow and become established because of unfavorable weather.

In another set of trials it was found that when cut potatoes are planted, two halves placed in a hill do not give so large a yield as four quarters, the tubers being the same size in each case. Or, to state it differently, the same amount of seed per acre will give larger yields the smaller, within certain limits, that the pieces are into which the seed potatoes are cut.

Other trials of similar nature but taking up other phases of the question of best yields in relation to economical use of seed material, were successfully carried out, but are too lengthy to be given in this connection. The whole subject will eventually be presented in detail in form of bulletins.

The value of spraying potatoes was another question which received attention. No disease affected the crop during the season of sufficient prominence to attract attention. The spraying must, therefore, be considered quite independent of its value as a fungicidal remedy. Bordeaux mixture was used and applied to the vines with a Stahl knapsack sprayer. Applications were made on June 22 and July 17. No difference was observable in the sprayed and unsprayed portions of the field until the latter part of the growing season, which was, by the way, very dry and unfavorable to the crop. As the vines began to ripen it soon became apparent that the sprayed portion retained its active green leaves better, and finally most of the hills in the unsprayed part were quite dead, while in the sprayed part they were mostly more or less green and living. The harvest proved that the indications of a better growth above ground was borne out by the yield, the sprayed part giving a total crop of about ten per cent increase over the unsprayed part, and of merchantable tubers a much larger increase still. The experiment certainly indicates a profitable use of Bordeaux mixture quite independent of its fungicidal value.

The very interesting question of sub-irrigation received a preliminary test this year. A piece of ground about thirty by fifty feet was underlaid in November, 1893, with common

three-inch tiling. It was placed ten inches below the surface, which was deemed as shallow as practicable to escape the plow and cultivator with certainty. The tiles were laid with unprotected joints on upper side but cemented below, thus checking too rapid escape of water into the soil when water is artificially supplied in dry weather, and permitting the freest service as a drain in wet weather. The lines of the tiling were placed parallel three feet apart with a very slight fall toward one end of the plat, where they were all connected and led into a dry well. At the other end of the plat each line of tile was brought to the surface by an upright section, through which water was supplied as required. The tile was laid the previous autumn, so that the soil might regain its accustomed compactness before the trial began. In the spring potatoes were planted in the drills above the tiles and extended to fifty feet beyond, thus securing a drained and an undrained plat lying end to end. Precautions were taken that the two pieces of ground should be as near duplicate as possible, except in regard to the sub-drainage. The full value of the trial was not secured, as a severe attack of bacterial blight at the beginning of the dry season, about July 1, soon destroyed most of the foliage upon the vines and seriously curtailed the yield. Water was supplied through the drains about twenty times during the season. The result so far as the comparative yield is concerned was highly satisfactory, the harvest showing a decided gain for each drill in the sub-irrigated portion over the other part. The trial is all the more decisive, as two varieties of potatoes and three methods of planting were used. The question of net profit can scarcely be stated intelligently in the limited space at command in this report, but will be discussed in the more extended account of the experiment to be presented hereafter in bulletin form.

The subject of potato scab has been dealt with in this department since its inception. It received some attention in the first bulletin issued by the department (No. 15, 1888), was studied with much thoroughness in 1889 and 1890 by the Assistant Botanist, Henry L. Bolley, leading directly to important preventive measures, and each year up to the present time more or less work has been done of both a scientific and practical nature. The efficient corrosive sublimate treatment

of the seed tubers has now been brought into satisfactory practical form, securing almost complete immunity from the disease. The subject will, however, be fully treated in a bulletin, now in the course of preparation, to be issued shortly, and need not be elaborated here.

Some study has been given to the proper number of stalks in a hill of potatoes, and means for securing the same. The present season a trial for thinning the stalks in a hill was made. Also a trial was conducted in the vegetation house to determine if the amount of water present in the soil at time of sprouting in anywise controls the number of stalks sent out by a tuber. The results of this year's work seem to indicate that water is not an important factor. Further study is required before a full statement can be given.

Vegetation House.

The work in the vegetation house upon the feeding habits of plants requires the presentation of too many details to be profitably summarized in this place. The series of phosphate experiments proved particularly interesting, especially with clay soil. With an ample supply of other food elements ordinary clay soil produced a crop of oats, when no phosphate was added, that attained only one-half the height of stalk and gave but one-thirtieth the yield of grain of sandy loam under the same conditions. Purslane; a vigorous feeder, especially dependent upon phosphates, showed a similar difference in clay and loam soils. More than fifty separate cans of soil with growing plants were used in the phosphate tests. Tests were also made with regard to potash applied to oats and buckwheat, and with nitrogen applied to corn, besides some miscellaneous tests, partly of a preliminary character.

Weeds.

The subject of weeds has attained an unexpected prominence during the last twelve months on account of the agitation regarding the Russian thistle. In July and the month following so many inquiries were received by the Station about the names and habits of particular weeds, in most cases under suspicion

of being the dreaded Russian pest, that it was decided to issue a bulletin giving more information than could be well conveyed in letters. At that time the Russian thistle was not definitely known to have gained a foothold upon Indiana soil, although since found to be established at several points along the northern border of the State, and the inquiries were generally accompanied by a piece of prickly plant, but recently come under observation. This weed, the wild or prickly lettuce, was therefore made the subject of a bulletin (No. 52) issued in November, 1894. The bulletin consisted of thirty-one pages and four plates, gives a history of the introduction of the weed into the United States, and especially into Indiana, its spread, and its present distribution. The status of the plant as a noxious weed is discussed, the opinion of many correspondents being given. Upon the question of the proper treatment to be given such a weed, a course of subjugation is advocated as more rational and practical than a factitious attempt at extermination.

Experiments have been in progress for some time upon the germination of cocklebur seeds, and other information pertaining to this weed is being collected with a view to the publication of a bulletin regarding it at an early date. Other weeds of more recent introduction are also receiving attention, such as the Russian thistle and spiny nightshade (*Solanum rostratum*).

The work of the department in regard to weeds during the last year has received a hearty response from farmers and landowners throughout the State, and it is believed that, as a result, better methods will prevail and more attention will be given to a matter that is intimately connected with successful farming. There is need, as pointed out in the bulletin referred to, for better weed laws, and there are indications that they will be early secured.

There are many less extended, but often highly important matters that have engaged more or less of the attention of the department during the year, but of these no suitable mention can be given in this connection.

Respectfully submitted,

J. C. ARTHUR,

Botanist.

REPORT OF THE VETERINARY DEPARTMENT.

To C. S. Plumb, Director:

SIR—The work of the Veterinary Department has been conducted on the line indicated in the last annual report.

The collecting of animal parasites was continued throughout the year. Specimens were taken from all post-mortems and clinics that could add to the collection. Sixty-three species were obtained, the hosts belonging to nineteen species. With few exceptions these have all been preserved.

Much time and work were devoted to securing a cabinet of normal and diseased tissues. Over four hundred slides were prepared for the microscope. These will be of much value in future work.

On June 19 and 20 a tuberculin test was conducted upon all the older and part of the younger animals of the station herd. Nineteen animals were tested. The tuberculin was obtained from the Bureau of Animal Industry, and was used as per the directions which accompanied it. The temperature was taken every hour for eighteen hours preceding the injection of 2 c. c. of the tuberculin. The temperature was taken every hour for the twenty hours succeeding. In most of the animals there was a slight rise of temperature on the second day, but no greater than in those than remained untested. This was due to the nervousness attending continuous stabling at a time they were accustomed to graze. The widest variation was two and two-tenths degrees. The average temperature was 101.3 degrees F. The increase in temperature the second day over the first was .52 degrees.

On October 15 six more of the young cattle were tested. The results were nearly the same as in the former case.

The immediate cause of the test was the loss of a very valuable short-horn cow by tuberculosis. The cow had been unwell for some time, but apparently with chronic indigestion. She was examined carefully, but no satisfactory diagnosis could be made for tuberculosis. As she was pregnant, her condition was attributed to some irregularity of position of the fœtus.

She was spared until she gave birth to a calf. Finding she made no improvement she was destroyed. Three tubercules upon the liver exceeded three inches in diameter, and several were more than an inch. All the organs of the abdominal cavity were covered with small tubercules. Those upon the lungs were of medium size, but none showed evidence of having discharged at any time. At no time had there been a cough, mucous discharge or symptoms of a lung affection.

The calf was killed and tubercules found in the mesentaries and upon the spleen.

Swine plague and hog cholera caused very great loss to the pork interests of the State the past year. The work which we attempted was to determine to what extent the breeders are responsible for the spreading and virulence of the epidemics. The matter of immunity was especially studied.

The various modes of castration were practiced upon horses, cattle, hogs and sheep. The new instrument known as the emasculator gave the best of satisfaction. Not a single ill result came from its use. For ease of manipulation and speed it is decidedly superior to the ecrasure. We can recommend it to any one who does his own work.

The iodide of potassium treatment for lumpy jaw (*actinomycosis*) was tried on three cases. One was of long standing and badly affected. The treatment failed. The others were recent, and made complete recovery. No evidence of return could be detected at the end of five months.

The so-called milk-sickness was reported from several localities during the early autumn months. In no case did the disease occur after I had been informed of its whereabouts. The disease has frequently been ascribed to the eating of white snake root (*Eupatorium ageratoides*). As a test, about eighty pounds of the weed were fed to a horse in four days (all he would eat). Not the first symptom of the disease was observed. In one woods pasture, where seventeen animals died, but little of the weed could be found.

The laboratory equipment has been much increased and is now fitted for research work. Few station experiments can be conducted, however, until a suitable hospital is provided.

Respectfully submitted,

A. W. BITTING,

Veterinarian.

REPORT OF THE HORTICULTURAL DEPARTMENT.

To C. S. Plumb, Director:

SIR—In some respects the past season has been quite satisfactory, from a horticultural standpoint; in others, quite the reverse. This, however, is to be expected where there are so many different lines of work in progress. The early spring gave promise of a bountiful fruit harvest, the reports which were received from the various sub-stations early in March indicated that the fruit buds of all kinds were in good condition. But the severe freezing weather later on made it necessary to modify these reports to a considerable extent. From all over the State came reports saying that fruit buds of all kinds were killed. While this was not so universal as was at first supposed, in the southern counties, where all vegetation was well advanced, much damage was done to peaches, plums, cherries and the early apples, while the later winter varieties did not entirely escape. In the central and northern counties the conditions were more favorable; the northern section had a fair crop of everything except peaches, and in favored localities a fair crop of these.

The meteorological records here at the Experiment Station show that the mean temperature during the first twenty-two days of March was a little above 50 degrees, while that of the remainder of the month was only 32 degrees. On the 20th, the thermometer registered 78 degrees, while during the 26th, it dropped to 11 degrees. This change of 67 degrees in less than a week was sufficient to kill many of the fruit buds. Only one of our foreign plums was able to set any fruit, but the native varieties were apparently uninjured, and bore full crops. This would seem to indicate that the buds of the foreign varieties are not so well protected as those of our native varieties.

The cherry crop was a little above the average. Some of the foreign varieties are proving to be very promising. Sixteen varieties of the Russian apple fruited the past season, and while many of them are of good quality, they all, so far as fruited, prove to be summer or fall varieties. It is our intention to begin crossing these next season with our native varieties, and it is believed that we shall secure some valuable results. See Bulletin No. 53, for description of varieties.

Varietal Tests of Small Fruits.

Our list of small fruits tested now comprises seventy-five varieties of strawberries, fifty varieties of raspberries and blackberries, sixty-five varieties of grapes, twenty varieties of currants and gooseberries. A number of new varieties have been sent to us during the year for trial. These will all be reported on in a bulletin, which will be prepared in time to give fruit-growers the necessary information concerning varieties before the planting season arrives.

Other Lines of Work.

A number of other lines of work have been carried on during the season, some of which are as follows: Testing the influence of climate on onions raised from seed. Treating seed potatoes for potato scab. Protecting fruit from the ravages of birds. Observations on the habits of and remedies for the fruit bark beetle (*Scolytus rugulosis*). The details concerning these experiments are given in Bulletin No. 53 from this Station, published last December. The increased interest manifested by farmers and fruit-growers throughout the State concerning the various injurious as well as beneficial insects, has involved a large amount of labor and correspondence in identifying specimens, and answering the long list of questions which have been received by this department. In this connection, a considerable amount of work has been done in testing the different forms of insecticides and fungicides upon fruit trees and vegetables, the results of which will be published in due time.

Respectfully submitted,

JAMES TROOP,

Horticulturist.

REPORT OF THE AGRICULTURIST.

To C. S. Plumb, Director:

SIR—The work of this department for the year 1894 has been in the main a continuation of the experiments previously begun. The growing season of 1894 was favorable to small grains in this locality, but very unfavorable to corn during July and August on the naturally drained soil of the Station farm. The drought was so severe as to cause an almost complete failure of many of the experiments with corn, and in no case was the yield much more than one half of a full crop.

A brief statement of the work of the year, with the results obtained, is given below under the appropriate headings.

I. EXPERIMENTS WITH VARIETIES.

1. *Wheat.* Number of varieties grown in 1894, 37; time under trial, one to eleven years; average yields, 24 to 38 bushels; yields in 1894, 28 to 46 bushels; leading varieties in the order of their average yields, Jones' Winter Fife, Early Red Clawson, Rudy, Velvet Chaff (brown smooth), Velvet Chaff (brown bearded), Raub's Black Prolific.

2. *Corn.* Number of varieties grown in 1894, 28; time under trial, one to eight years. This experiment was almost a complete failure in 1893, and again in 1894, owing to droughts. The leading varieties based on experiments previous to 1893 are in the order named: White Prolific, Boone County White, Yellow Nonesuch, Riley's Favorite, Haben's Golden and Purdue Yellow.

3. *Oats.* Number of varieties grown in 1894, 13; time under trial, one to eight years; yields, 47 to 53 bushels; yields in 1894, 34 to 68 bushels. Leading varieties in 1894, Improved White Russian, White Bonanza, Great Northern, American Banner, Superior Scotch, in the order named.

4. *Grasses.* One-half dozen plats of about $\frac{1}{15}$ of an acre each were seeded to grasses and clovers in the spring of 1893. During that year the plats were occasionally mown to even up the growth and keep the weeds in check. Nothing was removed from the plats. The following yields per acre of well cured hay were obtained in 1894 from a single cutting:—

1.	Alfalfa	3,080	pounds.
2.	Alsike clover	3,582	"
3.	Crimson or Scarlet clover	3,223	"
4.	Timothy and Mammoth clover	3,152	"
5.	Meadow fescue	2,435	"
6.	Orchard grass and common red clover	3,297	"

5. *Lathyrus sylvestris.* A quantity of the seed of this forage plant was sown in drills in the spring of 1894, mixed with buckwheat to mark the rows. The buckwheat came up promptly, but the *Lathyrus sylvestris* was exceedingly slow to germinate and appear above ground, and its growth later was equally discouraging. The stronger plants did not get above six or eight inches high, and the weaker four or five inches. Of course no crop was harvested. The seed was sown in compact, dark loam soil, and this may account for the poor results secured thus far.

II. Experiments With Thick and Thin Sowing and Planting.

1. *Wheat.* Quantity of seed, 2 to 10 pecks per acre; time under trial, nine years; range of average yields, 23 to 31 bushels; range of yields in 1894, 34 to 39 bushels; highest average yield produced from 8 pecks per acre; lowest average from 2 pecks per acre.

2. *Oats.* Quantity of seed, 4 to 12 pecks per acre; time under trial, nine years; range of average yields, 46 to 50 bushels; range of yields in 1894, 51 to 57 bushels; highest average yield produced from 8 pecks per acre; lowest average from 4 pecks per acre.

3. *Corn.* The individual stalks ranged from 11 to 20 inches apart in drills 3 feet, 8 inches apart; time under trial, nine years; range of average yields, 40 to 47 bushels; range of

yields in 1894, 12 to 22 bushels; highest average yields produced from stalks 11 inches apart; lowest average yield produced from stalks 20 inches apart. Yields of these plats were greatly reduced by droughts both in 1893 and 1894.

III. Experiments With Early and Late Sowing and Planting.

1. *Wheat.* Range of dates previous to the fall of 1893, September 18 to October 18; range of dates in the fall of 1893, September 13 to October 11; time under trial, six years; range of average yields, 26 to 32 bushels; range of yields in 1893-4, 39 to 43 bushels; highest average yield from sowing September 20; lowest average yield from sowing October 11; highest yield in 1894 from sowing October 4. The variation in 1894 from the average, as to date giving highest yield, is doubtless due to the exceptional character of the fall of 1893.

2. *Corn.* Range of dates from May 1 to May 29; time under trial, six years; range of average yields, 32 to 41 bushels; average yield from earliest planting, 41 bushels; average yield from latest planting, 32 bushels. The average yields are much reduced by the poor crops of 1893 and 1894.

IV. Experiments With Deep and Shallow Plowing for Corn.

This experiment has been conducted four successive years. The different depths of plowing are 4, 6, 8, 10, 12, 14 and 16 inches respectively. The common plow has been used to stir the soil only to the depth of 8 inches, the sub-soil plow being used for all greater depths. The range of average yields is 34 to 36 bushels; highest average yield from plowing 8 inches deep; lowest average from plowing 4 inches deep. The average yields were much reduced by the droughts of 1893 and 1894.

V. Experiments With Deep and Shallow Cultivation of Corn.

This experiment has been conducted six years, the depths ranging from 1 to 4 inches. Average yield from cultivation 1 inch deep, 46 bushels; from cultivation 2 inches deep, 45 bushels; from cultivation 3 inches deep, 44 bushels; from cultivation 4 inches deep (1894 only), 17 bushels. The above yields were considerably decreased by the droughts of 1893 and 1894.

VI. Experiments With Different Corn Cultivators.

Number of implements tested in 1894, 7; time under trial, one to seven years; average yields of corn (not including 1893, when this experiment was an entire failure) are as follows: *Corn plow*, average of six years, 53 bushels; *Spring-tooth cultivator*, average of six years, 54 bushels; *Gopher* (a cultivator with flat blades, which merely shaves the surface), average of five years, 52 bushels; *Tower's cultivator* (a shallow working implement), average of two years, 49 bushels; *Disc cultivator*, average of three years, 52 bushels; *Planet Jr.* (a one-horse adjustable cultivator) average of three years, 48 bushels; *Breed's Weeder* (a species of light, fine-toothed harrow, used only in 1894), employed early in season and followed by 1-horse harrow, 36 bushels.

VII. Experiment to Determine the Lasting Effect of Manure on Yield of Corn.

This experiment was begun in 1883 on a dark, firm loam, which has been growing corn continuously since 1880. Fresh horse manure was applied in 1883 and again in 1884, amounting for the two years to about 50 tons per acre. No manure has since been used. The alternate plats have received no fertilization since 1880, and doubtless sometime prior to that. The average increase in the yield of corn produced by the horse manure is nearly 11 bushels per acre. The aggregate increase in 11 crops is 118 bushels per acre. Although the season of 1894 was very dry, the increase was 4½ bushels per acre, showing that the manure has not yet been exhausted. The crop of 1887, which was almost an absolute failure, is not included in the figures given above.

VIII. Experiments with Rotative Cropping and Continuous Grain Growing, Without Manure.

The two series of plats upon which this experiment has been conducted for fourteen years lie side by side and have apparently similar soil. On series H grain crops only are grown. On series F the same grain crops (corn, oats and wheat) are grown in rotation, in connection with crops of beans, roots and grass. The average yields of the grain crops for the last seven years are as follows: On series H, corn, 27 bushels; oats, 27 bushels; wheat 15 bushels. On series F, corn, 32 bushels;

oats, 34 bushels; wheat, 22 bushels. Average gain per acre from rotative cropping, corn, 5 bushels; oats, 5 bushels; wheat, 7 bushels. The average percentages of gain from rotative cropping are: Corn, 19 per cent.; oats, 19 per cent.; wheat, 47 per cent.

IX. Experiments with Heavy and Light Applications of Manure and Fertilizer.

In this series of experiments, which began in 1889, applications of fertilizers and manure in heavy and light doses were made in 1890 and succeeding years. Fresh horse manure and high grade complete fertilizers have been used in these experiments. The average increase in yield per acre from fertilization and manuring has been, for the several crops grown, as follows:

	Barley.	Corn.	Oats.	Wheat.	Sugar Beets.	Hay.
Heavy fertilization .	12.3 bu.	7.7 bu.	10.9 bu.	9.5 bu.	*13,965 lbs.	1,425 lbs.
Light " .	9.1 "	9.7 "	10.8 "	8.1 "	11,705 "	994 "
Heavy manuring. . .	8.2 "	10.5 "	13.7 "	7.3 "	10,325 *"	1,025 "
Light " . . .	8.6 "	9.3 "	11.8 "	6.0 "	12,195 "	713 "

*Grown only one year, hence not an average.

X. Experiments with Complete and Partial Fertilizers and Manures.

This experiment was also begun in 1889, although the first application of fertilizer and manure was made in 1890. The crops of 1892 and 1893 were grasses, which, according to the plans adopted, received neither fertilization nor manure. It follows, therefore, that but three crops—oats in 1890, wheat in 1891 and corn in 1894—have received applications of fertilizer and manure. The grass crop of 1892 was almost a complete failure in this experiment, owing to a "poor catch." The plats were re-seeded and a fair stand secured, but the drought of 1893 greatly reduced the yield. The yields per acre of the several crops are as follows:

	Oats.	*Wheat.*	*Hay.*	*Corn.*
Average increase from complete fertilization	5.0 bu.	*2.7 bu.	*767 lbs.	*4.9 bu
Average increase from partial fertilization	3.0 bu.	*1.3 bu.	*57 lbs.	*1.8 bu.

*Loss.

As these results are quite anomalous, it may be explained: (1) That complete fertilization made the wheat very rank, thus cutting down the yield of this crop and also injuring the stand of grass which followed. (2) The excessively dry weather in July and August of 1894 doubtless had a more injurious effect upon the ranker growth of corn on the plats which received the heavier fertilization.

XI. Relation of Early and Late Planting of Corn to Time Required to Mature the Crop.

This experiment was begun in 1892, and has therefore been continued three years. Unfortunately, the latter part of each of the three seasons has been abnormally dry, resulting in the premature ripening or drying up of the varieties under trial. The results obtained are therefore only approximate, as it was practically impossible to tell just when each variety matured.

Ten varieties of corn, differing a week or ten days in time of ripening, have been grown in this experiment. The accompanying table shows the date of planting each year and the average number of days from planting to maturity for each of the dates.

Date of Planting.			Days to Mature—Average of Three Years.
1892.	1893.	1894.	
	May 6	May 5	124
	May 16	May 14	119
May 24	May 27	May 24	114
June 4	June 6	June 3	111
June 14	June 16	June 13	104

XII Early and Late Harvesting of Wheat in Relation to Yield and Weight Per Bushel.

The purpose of this experiment, which has been conducted three years, is to ascertain at what stage of maturity the heaviest grain and largest yield can be secured. In 1892 the wheat was in the "dough stage" at the time of the first cutting. In 1893 the bulk of the crop was again in the "dough stage" at the time of the first cutting; also, the later heads were in the "milk." In 1894 the first cutting was made when the wheat was generally in the "milk stage." The intervals between the cuttings were each two days in 1892 and 1893.

The second cutting in 1894 was also two days after the first, but owing to the slow maturing of the crop, the remaining intervals were increased to four days each. The plats cut "very late" in 1893 and 1894 were dead ripe, the grain shattering considerably when harvested. The results of the three-year test are embodied in the accompanying table.

YIELDS FROM EARLY AND LATE HARVESTING.

Harvested.	1892. Lbs. per struck bushel.	1892. Bushels per acre.	1893. Lbs. per struck bushel.	1893. Bushels per acre.	1894. Lbs. per struck bushel.	1894. Bushels per acre.	Average bushels per acre.
Very early	. .	. . .	61.1	23	59	*25.3	‡24.17
Early	57.5	*25.7	60.5	23	60.9	*30 5	26.42
Medium	57	*24.6	61	†23.3	33.4	†34.3	27.44
Late	56.5	*25.9	60.8	23.7	63.3	*35.8	28.47
Very late	. . . . .	. . . . .	61.1	22.7	62.7	*33.5	†29.24

* Average of two plats.
† Average of three plats.
‡ Average of two years only.

The results obtained thus far indicate that the harvest should begin promptly when the wheat is in the "dough stage," and be completed by the time the crop is fully ripe.

XIII. Co-operative Test With Varieties of Wheat.

The purpose of this experiment, which began in the fall of 1893, is to ascertain the adaptation of a few leading varieties of wheat in the different sections of the State. The results of this experiment are summarized in the table which follows, the yields being given in every case in bushels per acre.

SHOWING RESULTS BY COUNTIES.

Variety.	Tippecanoe.	Jefferson.	Madison.	Whitley.	Dekalb.	Average yield and weight.
Red Clawson	40	39.72	25.74	42.04	33.97	36.29
Lbs. per bushel	58.75	64	55.5	60.5	58	59.35
Jones' Fife	41.33	42.23	24.60	43.15	31.60	36.58
Lbs. per bushel	61.25	65	56	62.5	60	60,75
Michigan Amber	*35.67	35.13	26.02	33.47	26.53	36.36
Lbs. per bushel	*61.88	65	57	62	62	61.58
Velvet Chaff	*35.37	. . . . .	24.88	38.42	26.23	31.23
Lbs. per bushel	*63.25	. . . . . .	59.4	63.5	62	62.04
Average yield	39.08	39.03	25.31	39.02	29.58	. . . . .
Average weight	61.03	64.67	56.98	62.13	60.50	. . .

* Average of two plats.

XIV. Co-operative Test of Varieties of Corn.

This experiment was begun in the spring of 1894, and is to be continued for two or three years at least. The primary purpose is to determine the yield and adaptation of the several varieties under trial in different portions of the State. The results have not been reported with sufficient fullness as yet for publication.

Most of the experiments referred to above will be continued until reliable and satisfactory conclusions can be obtained.

Respectfully submitted,

W. C. LATTA,

Agriculturist.

APPENDIX.

NEWSPAPER BULLETINS PUBLISHED BY PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION, TO JANUARY 1, 1895.

NEWSPAPER BULLETIN No. 1. AUGUST 1, 1891.

HOW TO PREVENT SMUT IN WHEAT.

Numerous reports have been received at the Experiment Station of losses in the wheat crop by smut. The matter is a serious one, and farmers are beginning to realize it, and wish to know how it can be prevented.

There are two kinds of smut which destroy wheat heads. The first form is known as *Stinking Smut*, and while the seed head does not change its form, the wheat seeds become black, soft, stinking and are ruined. The second form is *Loose Smut*. The whole head turns black and to powder, and falls away, leaving only a bare stem where it was. In both cases this black powder consists of countless minute spores, which blow about and mingle with the grain in threshing and then sprout and grow in the wheat plant after it is above the ground, finally blasting the head. If these black spores, too small to be seen by the naked eye, can be destroyed before the seed is planted, no smut will injure the wheat for harvest.

Experiments have been conducted at the Purdue University Experiment Station, for the purpose of preventing these diseases, and as a result of the work here, the following remedy is presented:

For Stinking Smut. Fill a tub or half-barrel about two-thirds full of water, warmed up to 140 to 145 degrees temperature. Place a bushel of wheat seed in a loose or thin sack (say a coffee sack), and dip it into the tub and thoroughly work the water in among the seeds. Let the seed stand in this hot water at least five minutes. *The water must not be allowed to get cooler than 130 degrees, and the nearer it is to 140 degrees the more satisfactory the treatment.* By this method we have entirely prevented the disease, while seed from the same source, *not treated*, caused a large loss in crop. The seed will dry in twenty-four hours if spread on a barn floor, and occasionally turned. Or it can be dried in a short time if mixed in land plaster or dry road dust.

For Loose Smut. Our experiments only enable us to *suggest* treatment for this disease the present year, which is to dip the seed as in treating above, only having the water 10 degrees warmer (150 to 155 degrees). We believe this treatment will largely prevent the smut occurring in the crop. Our experiments have shown us that water at 135 degrees will not prevent the disease.

We hope our wheat farmers will try these tests, and let us hear from them as to the results. It is an important matter. The medicine costs nothing. The experiment takes but little time. If you are farming for profit, you can not afford to plant contaminated seed wheat.

This station publishes its experimental results, for the benefit of farmers, from time to time. A wheat bulletin will soon be issued. Your name and post office address will secure you these documents *free.* Address

C. S. PLUMB, *Director.*

LaFayette, Ind.

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION,
NEWSPAPER BULLETIN No. 2. OCTOBER 19, 1891.

THE FOOT AND MOUTH AFFECTION OF CATTLE.

The wide spread prevalence of diseases affecting mainly the mouths and feet of cattle (sometimes sheep and deer) has occasioned considerable unwarranted alarm among cattle owners.

Dr. Williams, the Veterinarian of Purdue University Experiment Station, has had occasion to make critical examinations of cattle thus affected, both in Illinois and Indiana, and has treated them with abundant success, and the following consideration of the disease and its treatment is offered by himself:

This disease has been confounded with the contagious foot and mouth disease of Europe, which does not prevail and has not recently existed in America. The form of foot and mouth disease, now quite prevalent in Indiana, was first noticed in 1890 in Missouri and Illinois. It is characterized by stiffness and soreness of the limbs, rendering some animals almost unable to walk. The muzzle and lips become hard and swollen, ropy saliva dripples from the mouth, and the jaws are moved in a spasmodic, jerky manner. The lining membrane of the mouth is colored bright red or scarlet ; the pad (gums of the upper jaw, against which the front teeth of the lower jaw press), and the gums along the front teeth slough off, leaving a raw surface extremely sore, which bleeds easily. The nose and lips suffer similarly, but not to so great an extent, and the teats are also frequently sore.

Post mortem examination shows the stomach and intestines to be inflamed in patches throughout their entire extent. Constipation is usually present, ending frequently in diarrhœa. It has none of the characteristic symptoms of the contagious foot and mouth disease of cattle, and all efforts to transmit it from one animal to another have so far failed. Last year it prevailed for a few weeks only, in late summer and autumn, and it is quite probable that it will again cease very shortly. It is possibly due to some acrid or irritant substance contained in the food. The irritation of the bowels and slight constipation should be overcome by giving one quart of *raw* flax seed oil and following with one pint of it twice daily until the bowels move freely. The mouth should be bathed twice daily with a mild astringent wash, such as the following: One-half ounce tannic acid, one ounce powdered borax, eight ounces glycerine, mixed together with enough water to make one quart. Soft, sloppy food only should be fed and plenty of good water given for drinking.

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION, NEWSPAPER BULLETIN No. 3. MARCH 25, 1892.

TEST OF VARIETIES OF OATS, BY W. C. LATTA, AGRICULTURIST.

Twenty-seven so-called varieties of oats were grown on the Station farm in 1891. The varieties were sown April 25, at the rate of two bushels per acre, in a dark, compact, well-drained and very fertile soil, which proved to be quite uniform in productiveness, as shown by the nearly equal yields on the duplicate plats—Nos. 1, 9, 17 and 32.

The yields per acre, by weight, and other points of most interest to farmers, are shown in the accompanying table:

TABLE SHOWING YIELDS OF VARIETIES, ETC.

2	ale).	12	Weak	[illegible]	48.4
3		12	Weak	43.5	53.3
4		19	Strong	35	67.9
5		19	Strong	34.5	63.1
6		12	Very weak	39	43.6
7		20	Strong	31	49.9
8		12	Very weak	41.5	49.2
9		19	Strong	32.5	61.5
10		22	Very strong	32.5	49.9
11		20	Medium	35.5	66.0
12		22	Medium	30	48.9
13		20	Medium	36	73.9
14		21	Weak	38.5	58.4
15		23	Very weak	30.5	51.8
16		16	Very weak	40	50.5
17		19	Strong	34	60.0
18		20	Medium	35.8	69.1
19	and.	21	Very strong	29	50.5
20		20	Medium	39	59
21		16	Weak	37.5	47.7
22		20	Medium	32	52.9
23		16	Very weak	40	39.5
24		18	Weak	37	39.5
25		19	Very strong	34	60.3
26		19	Strong	32.5	42.9
27		20	Strong	29	38.2
28		23	Strong	23	31.2
29		20	Strong	40	64.1
30		21	Medium	31.5	57.0
31		21	Strong	33.5	69.8
32		19	Very strong	34	90.9

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION
NEWSPAPER BULLETIN, No. 4, APRIL 22, 1893.

TESTS OF VARIETIES OF SWEET CORN, BY JAMES TROOP, HORTICULTURIST.

Out of fifty different varieties of sweet corn tested at the Purdue University Experiment Station, the following are recommended as being especially desirable either for market or family use.

Cory is one of the earliest varieties grown, but is not recommended except for the first planting, as the quality is not of the best. Next to this in earliness is MARBLEHEAD, which is much better in quality as well as in productiveness. MINNESOTA matures at about the same time as Marblehead, and, although small, is quite productive and of good quality. HUNTINGTON is a new variety, nearly as large as Egyptian, and ripens with the earliest. This will evidently prove a valuable addition to the list of early varieties.

Crosby follows closely the early sorts and is of good size and quality, while CONCORD, maturing a little later, is large, productive and one of the best in quality. AMBER CREAM bears quite large ears, grains amber colored when mature, has a rich flavor and is altogether a very desirable sort. HONEY sent out several years ago differs from other varieties in the purplish color of its stalks and leaves. It is large and of first-class quality.

Hickox Improved follows those named above and is a vigorous grower, very productive, produces large ears, and is of excellent quality. STOWELL is still the favorite variety, and is probably planted more largely for canning than any other variety. It is one of the best, both in quality and productiveness. SILVER COIN is another new variety, ripening about with Stowell, about the same in quality, and "remaining longer in edible condition."

Ne Plus Ultra is a small variety with irregular rows, or rather no rows at all, but it is one of the sweetest and best for family use in the whole list. It matures with Stowell.

Black Mexican is not a popular variety for the market, on account of its dark color, but its quality places it among the best for table use.

The following five varieties are recommended for a succession: Cory, Concord, Ne Plus Ultra, Stowell and Black Mexican.

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION, NEWSPAPER BULLETIN, No. 5, AUGUST 3, 1893.

TESTS OF VARIETIES OF STRAWBERRIES, BY JAMES TROOP, HORTICULTURIST.

For the benefit of those farmers who contemplate setting out a strawberry bed this fall for family use, the following information concerning varieties is sent out at this time. These ten varieties are taken from a list of over one hundred which have been tested for two or more seasons on the experiment grounds at this Station and have been selected with special reference to their desirability for the table. They are also divided equally between those varieties having pistillate and those having perfect or bisexual flowers, which is indicated by the letters P. and B.

Brunette (*B*). This was originated by Mr. G. Cowing of Muncie, Ind. The plant is a good grower and productive, berry dark red and of the very best quality. Especially desirable for home use.

Bubach's No. 5 (*P*). Under good treatment this is one of the largest and most profitable varieties that we have grown. The quality is a little inferior, however.

Katie (*B*). This has not become generally known, but it is really a first-class berry for the table. Quite early, productive of good size and quality.

Edgar Queen (*P*). A comparatively new variety which has not been advertised very extensively, but it has given us better satisfaction than many others which have been so highly praised.

Lovett's Early (*B*). Is a good grower, productive, and the fruit of excellent quality, but not so early as the name would

indicate. This would do well to set with *Greenville* (*P*), which is an Ohio berry and has given good satisfaction wherever tried. Desirable for either the table or market.

Parker Earle (*B*). Is a medium late berry and would do well to plant with *Shuster's Gem* (*P*). Both these varieties are quite productive, of good size and quality. The first, however, does not produce many plants.

Cumberland (*B*). In many localities this old variety continues to be a favorite. With us, however, it has come to be a very shy bearer and for that reason alone I do not recommend it for general cultivation.

Warfield No. 2 (*P*). For an all round berry this stands at the head of the list. The plant is small, but a wonderful grower and very productive when given good care, as all varieties should have. The berry is a dark glossy red, not overly large, rather tart, which quality it retains after being canned. It is the best canning berry we have tried.

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION, NEWSPAPER BULLETIN No. 6, MAY 9, 1894.

A SUBSTITUTE FOR COFFEE, BY CHARLES S. PLUMB, DIRECTOR.

While no substitute will satisfy the lover of high-grade coffee, the peculiar properties of coffee as a drink render it unsuited to a few people in every community. These few persons frequently make use of a substitute, which, while lacking the alkaloid of true coffee, in a measure imparts to the fluid made from it a flavor similar to that of coffee. Such a drink may be palatable, nourishing and well adapted to the person using it.

The purpose of this brief bulletin is to direct attention to what seems to be a desirable and easily available substitute for coffee, such as can be grown upon the farm in this latitude, viz.: the Soy or Soja bean.

The Soy bean (*Soja hispida*) is a Japanese plant that has been but little grown in America. It has an upright, stiff, bushy form, under favorable circumstances attaining a height of three feet. There are three large leaves on a leaf stem. Short flower shoots come from the axils of the leaves,which with maturity produce pods in clusters of two or three. Each pod contains from two to four seeds, a little longer than broad, being about three-eights of an inch in length. One plant may produce a large number of pods and leaves. The plant sends a vigorous root down into the soil. The leaves, stems and pods are as a rule very hairy.

The writer's attention was first directed to the peculiar merits of the roasted Soy bean, as a substitute for coffee, by Mr. L. D. Brown early in 1892, who was then a farmer in this county. In a letter, Mr. Brown says: "We have used it almost exclusive of other coffee, for coffee, for many years—seven or eight I believe. I have raised 782 beans on one stalk from one bean planted, and had sixteen bushel on one acre in Tippecanoe County."

The seed should be planted about thirty inches apart in rows with a bean every six to nine inches in the row. The ground should be prepared as for any other beans. The seed should not be planted until the ground is well warmed, about the latter half of May, though a satisfactory crop has been gathered at this Station from seed planted about the middle of June. Yet the season may be too short if planting is delayed much beyond June first. After the beans are ripe enough the plants should be mowed off or pulled up, and dried in the field in small piles or stacks, after which they may be taken to the barn and threshed out. Care should be taken not to harvest when the pods are too ripe, or they will shell in handling. A flail is a satisfactory instrument for threshing them out with, for they must be broken as little as possible in shelling.

Samples of Soy beans grown upon the Station grounds in 1892 were analyzed in the laboratory under the direction of Prof. Huston, and some of the roasted bean from the same source was also analyzed. Analyses are also given of the true coffee bean, roasted and unroasted, according to Kœnig,* and of artificial coffee beans and barley coffee, as published by Dr.

H. W. Wiley, Chemist of the United States Department of Agriculture.†

	SOY BEAN.		COFFEE.		Artificial Coffee.	Barley Coffee.
	Unroasted.	Roasted.	Unroasted.	Roasted.		
Moisture	6.36	78	11.19	3.19	5.14	3.45
Fat	18.34	1.61	13.23	15.63	2.19	3.25
Protein	32.93	37.83	. . . .	. . . .	10.75	9.38
Fibre	5.50	26.56	27.72	24.27	3.96	4.25
Ash	5.81	6.73	3.48	3.75	1.20	3.36
Carbhydrates	31.06	6.49	34.77	39.73	76.66	70.13
Total nitrogen	5.27	6.05	1.87	2.31	. . .	. . . .
Albuminoid nitrogen	5.13	5.64	. . . .	. . . .	. . .	. . . .
Real albuminoids	32.10	35.27	8.43	12.05	. .	. . .
Caffeine	. . . .	. . . .	1.18	1.38	. .	. . . .

* Blyth: Foods; 1888, p. 375.

† Foods and Food Adulterants, Bull. 13, part 7, Div. Chem. U. S. Dep't Agric., 1892.

Of the Soy coffee, 17.07 per cent. became soluble when boiled in water for drinking. The one main and essential difference between the seeds of the Soy and coffee is that one contains an alkaloid—caffeine—to which is due its peculiar flavor, which the other lacks. Both contain considerable fat, fibre and albuminoids, but the amount of available nutriment in either case would be inappreciable in a cup of coffee. That there should be so close a relationship in the amount of fat in each is of special interest. It is important to note that the Soy bean roasted is more nutritious than the artificial coffee or barley coffee sold in the market, and that the two latter contain but little fat and a great deal of carbhydrates (starch and sugar mainly).

As tried in the family of the writer, the drink made from the Soy bean was agreeable, and enjoyed more than some of the so called coffee served in some hotels and restaurants. I have no hesitation in recommending farmers to make a drink from roasted Soy beans, rather than buy the cheap grades of coffee sold on the market, that in so many cases are adulterated with burnt pastry beans, peas, chicory, etc. Drink made by a number of persons in this community from the roasted Soy bean was much relished.

A tablespoonful of the ground beans makes a cup of coffee. Mr. Brown recommends using one-fourth cup of common coffee and three-fourths cup of Soy to begin with, and one will thus more readily become accustomed to it. If too strong, it has an unpleasant odor, and may be diluted with boiling

water. Special care should be taken in roasting. The hull of the bean should be brown, and not black, and properly roasted, and the berry should grind easily in the mill.

In 1892 a man by the name of Cole, of Missouri, advertised extensively at $3.50 per pound, cash with order, what he termed "Cole's Domestic Coffee Berry." This so-called coffee, a sample of which was sent to this Station, was made from nothing else than Soy beans, the seed of which can be secured of leading seedmen at from 10 to 15 cents a pound. For those who desire a substitute for coffee as a drink, I suggest that they secure a half a pound or pound of this seed, and grow a small crop, and made a trial of it The plant will grow in very hot, dry weather, when many plants would suffer greatly. It is also important to note that the beans are much relished by some as a vegetable, while the plant as a whole makes a desirable forage.

Other substitutes for coffee have been furnished by correspondents of the Rural New-Yorker to a subscriber of that journal who wished to learn of something of the kind.* For the benefit of the readers of this bulletin, I quote from those articles.

The editor says: "We have used roasted rye, and also dried and ground carrots, but can't say that we 'hanker' after them. The Soy bean is used to some extent as a coffee substitute."

"The German peasantry make a substitute for coffee by mixing equal parts of roasted malt and chicory. From this mixture, steeped in boiling water, a nourishing beverage is obtained which is said to be of agreeable taste and flavor."

A Rhode Island physician says: "I have used many substitutes for coffee, and the best I have tried is roasted barley. Cook the *whole* barley a long time, or until the liquid is dark in color, then add one-fourth or one-third of the usual amount of ground coffee. This will make a very palatable drink; the barley alone is better than rye, chickory or okra seeds." This testimony is further endorsed by W. H. S., of Watertown, N. Y., who also adds: "Put it into the oven and brown, and use a little more for each person than you would of coffee, stirring it up with a little molasses and water before steeping."

B. W. H., of W. Bloomfield, N. Y., says: "The best coffee substitute I know of is made from bran. It is considered very

*Rural New-Yorker, May 27, June 10, 17 and 24, 1893.

healthful. I have used it for three years, and I am not tired of it yet. Five quarts of bran and one of molosses (Porto Rico preferred), mixed thoroughly, and browned in an oven like coffee. When it is taken from the oven, add one pound of ground Java coffee. Measure like ordinary coffee, and boil twenty minutes. No egg is required for settling. Three quarts of bran and a pint of molasses form a good preparation with a pound of coffee."

W. J. B., of White Lake, S. D., gives the following: "Into good cooking molasses stir bran until it is as thick as it is possible to stir with a spoon, press into a baking pan about one and one-half inch deep, bake in a slow oven (like fruit cake) until of a rich dark brown color, but do not let it scorch, cut out, and keep in tin or glass; it is very hard when cold, if baked properly. Take a lump about as large as a large hen's egg for four persons, pour on boiling water, boil it a few moments and serve as other coffee; season to taste. I have tried many substitutes, but never found any other to suit, but this was very good. I call it bran coffee."

The purpose of this communication is not against the use of pure coffee, which for those with whom it agrees is decidedly superior to a substitute, but for the benefit of those who desire to use a substitute for economy or health considerations. In view of the large amount of highly adulterated coffee sold on the market, wherein the cereals and peas and beans play an important part, it would seem just as well for more of the people who buy the low grade, cheap coffees to make their drink out of a substitute which will answer the same purpose in every respect and cost materially less.

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION.
NEWSPAPER BULLETIN, No. 7, JUNE 14, 1894.

AN OBJECTIONABLE FOOD PRESERVATIVE, BY H. A. HUSTON, CHEMIST.

In the month of December, 1893, I received from Mr. H. F. Smith, of Laporte, Indiana, a package of material for use in preserving fruits and other perishable food material. Mr. Smith stated that the compound was for use in the "Great

French Preserving Process," the business headquarters of which were in Chicago. It was also stated that various fruits on exhibition at the World's Columbian Exposition were preserved by this process.

The examination of the compound showed that it was composed of sulphur, charcoal, nitrate of soda, cane sugar and common salt. The salt may have been an impurity in the nitrate of soda used. The composition of the sample was:

Cane sugar	14.20 per cent.
Salt	1.42 per cent.
Nitrate of soda	1.36 per cent.
Sulphur	57.63 per cent.
Charcoal, moisture and insoluble matter	25.64 per cent.

The essentials of the directions for the use of this material were that the compound should be burned in a closed space and the fumes arising from the burning should be absorbed by water placed in suitable vessels, and that the fruit in some cases should also be exposed to the fumes. Finally the fruit was to be placed in the water which had absorbed the fumes of the burning compound and the vessel closed.

The burning of the compound would result in the production of sulphur dioxide, also known as sulphuric acid, as one product, and it is this substance which exerts the preservative action in the process. The other ingredients are merely to aid in the burning of the sulphur.

This sulphur dioxide is an intensely poisonous gas and its use is prohibited as a food preservative in European countries. When the gas is absorbed by water, sulphurous acid, a powerful therapeutic agent is formed. There is no doubt that its preservative action will be effective, for it is one of the best antiseptic and bleaching agents. But there are grave objections to the indiscriminate use of powerful therapeutic agents in food.

The advertising matter submitted to us calls attention to the very large profit arising from the sale of this compound and to the larger profits in disposing of rights to sell it in certain territory. No doubt the profit ought to be large, for that sent by Mr. Smith sells at one dollar per pound, while the cost of the material in one pound would not exceed six cents, even if material of the very best grade was used in its manufacture.

The State Dairy and Food Commissioner of Minnesota has recently condemned in his report the use of material which he examined, sold under the name of the Great French Preserving Process, and Mr. Smith states that *The Poultry and Bee Keeper* wrote up the matter in 1887, at which time the process was offered as a means for preserving meat.

Attention is again called to the matter because it seems probable that the material will be offered to farmers as a means for preserving fruit for food purposes.

FINANCIAL STATEMENT.

The Agricultural Experiment Station of Indiana in account with the United States, for the year ending June 30, 1894.

DEBIT.

Appropriation		$15,000 00

CREDIT.

Salaries	$6,585 99	
Labor	3,329 48	
Supplies	1,869 33	
Printing, stationery and bulletins	1,128 02	
Improvements	495 43	
Care of buildings	440 00	
Repairs	254 29	
Apparatus and fixtures	235 20	
Books and periodicals	185 09	
Insurance	158 95	
Express, freight and hauling	127 52	
Live stock	48 25	
Postage	44 20	
Gas	40 70	
Traveling expenses of investigators	39 65	
College association membership	15 00	
Telegrams	2 90	
Total		$15,000 00

The above is a correct statement of the general fund of the Agricultural Experiment Station of Indiana, for the year ending June 30, 1894.

E. A. ELLSWORTH,
Secretary Board of Trustees.

IMPROVEMENT FUND EXPERIMENT FARM FOR YEAR ENDING JUNE 30, 1894.

DEBIT.

Balance unexpended June 30, 1893	$1,263 67	
Receipts from farm	1,121 69	
Total		$2,385 36

CREDITS.

Salaries	$1,702 29	
Labor	169 95	
Supplies	136 58	
Balance unexpended	376 54	
Total		2,385 36

The above is a correct statement of the Improvement Fund for year ending June 30, 1894.

E. A. ELLSWORTH,
Secretary Board of Trustees.

PURDUE UNIVERSITY.

EIGHTH ANNUAL REPORT

OF THE

Agricultural Experiment Station.

LA FAYETTE, INDIANA.

1895.

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.
1896.

PURDUE UNIVERSITY.

EIGHTH ANNUAL REPORT

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Agricultural Experiment Station.

LA FAYETTE, INDIANA.

1895.

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.
1896.

THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
INDIANAPOLIS, January 18, 1896.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF AUDITOR OF STATE,
INDIANAPOLIS, January 20, 1896.

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

A. C. DAILY,
Auditor of State.

January 20, 1896.

Returned by the Auditor of State, with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

MYRON D. KING,
Private Secretary.

Filed in the office of the Secretary of State of the State of Indiana, January 20, 1896.

W. D. OWEN,
Secretary of State.

Received the within report and delivered to the printer January 21, 1896.

THOS. J. CARTER,
Clerk Printing Bureau.

To the Governor:

I herewith transmit the annual report of the Purdue University Agricultural Experiment Station, due February 1, 1896.

Very respectfully,

C. B. STUART,
President Board of Trustees.

January 16, 1896.

To the President of the Board of Trustees.

I herewith present the annual report of the Agricultural Experiment Station of Indiana, due on or before the 1st of February, 1896, the same being required by section 3 of an act entitled "An act to establish agricultural experiment stations in connection with the colleges established in the several States, under provisions of an act approved July 2, 1862, and of the acts supplemental thereto."

This report consists of a report of the Director of the Station, and the financial report of the Secretary to the Board of Trustees.

Respectfully submitted,

J. H. SMART,
President.

PURDUE UNIVERSITY, LAFAYETTE, IND., January 16, 1896.

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Joseph C. Arthur, D. Sc...Botanist

Arvill W. Bitting, D. V. M................................ Veterinarian

Jesse M. Barrett, B. S., A. C....................Assistant Chemist

William Stuart, B. S.................................Assistant Botanist

EIGHTH ANNUAL REPORT

OF THE

Purdue University Agricultural Experiment Station.

REPORT OF THE DIRECTOR.

President James H. Smart:

SIR—I have the honor to herewith transmit to you the Eighth Annual Report of the Purdue University Agricultural Experiment Station for the year 1895.

In experimental work there has been more activity at the Station during the past year than common. Some lines of investigation have been discontinued and others elaborated. As a whole the increase of work has been along lines already established, rather than in the number of experiments. The beet and potato investigations have in the past required a very large amount of labor from the chemical and botanical departments, respectively, but this work has been very greatly reduced in extent, thereby affording these departments opportunity to give greater attention to other experiments.

Without detailing the several lines of investigation in progress during the year in the different departments, I wish to call attention to some of the more noteworthy research work.

In 1894 the Veterinarian began observations upon the occurance of the disease known as milk sickness. Two localities, Logansport and Rensselaer, were visited, but no very satisfactory records were secured. This disease has been commonly attributed to domestic animals eating *Eupatorium ageratoides*

yet there is but little information of an accurate character available in literature substantiating this opinion. A quantity of this weed was secured and fed to stock at the Station, but with no deleterious effects. Early in the summer of 1895, milk sickness occurred with much severity in a flock of sheep in a woods pasture about a mile from the Station, and for some weeks Dr. Bitting was enabled to take valuable records of the disease and its effects. Numerous *post mortems* were held and it was well established that the disease was caused by a bacillus very closely resembling that of anthrax. The investigations conducted relative to this malady were among the most important ever undertaken by the department, and add much new evidence to that already on record. This work will be prosecuted as opportunity in the future permits.

Another important investigation in progress in the Veterinary Department is a continuation of the study of tuberculosis and the use of tuberculin. In November twenty-eight cattle at the farm were subjected to the tuberculin test, and five of these gave evidence of having tuberculosis by the marked rise of temperature. Two others had a rise of temperature which in a measure placed them under suspicion. The five animals referred to were slaughtered in the hospital in the presence of a number of physicians, some of the LaFayette City Council, newspaper men, one of the trustees and yourself, and in every case unmistakable evidence of the disease showed the accuracy of the test. These animals had the disease in its early stage, so that it would have been impossible to have detected it by physical examination. The two animals giving a suspicious rise of temperature were quarantined, and the cattle barn was given a thorough washing and fumigation.

As this is an appropriate opportunity I here desire to call your attention to a few facts in relation to this subject. Tuberculosis in cattle is identical with human consumption. The disease is contagious and is most readily disseminated by means of the dried sputum cast off by cattle where the tubers in the body are suppurating. There is abundant evidence to show that the disease is also transmitted to humans through the use of milk from cows having tuberculosis in an advanced form

The first experiments with tuberculin in Indiana, it is believed, were made by this Station in 1894. In the meantime, the prevalence of tuberculosis in some of the eastern States and

also in Wisconsin has caused a remarkable activity in testing herds with tuberculin. The accuracy of tuberculin as a diagnostic agent has been established, as a result of tests up in the hundreds of thousands. As a result of this, laws have been placed upon the statute books in a number of States relative to the control of this disease and a war of extermination is now in progress. The farmers of Massachusetts, from one end of the State to the other, are calling for the inspection of their herds by the tuberculin test, and an effort is being made to reduce the prevalence of this disease. In New York State, for three years the subject has been receiving a large amount of attention by stockmen and consumers of milk, as well as the health authorities.

Tuberculosis is prevalent among cattle all over the country. Indiana is not exempt, although it is believed the malady is not as prevalent here as in some States where cattle are kept very closely confined together in stables during most of the year. Without doubt, however, it will be a comparatively short time before this State will find it necessary to adopt measures of a character that will result in reducing the prevalence of tuberculosis among our herds, and that will give a degree of assurance to consumers that the milk they are purchasing is perfectly wholesome. It is my feeling that this Station should lead in those measures which will promote the most intelligent consideration of this subject by the people of Indiana, and I trust that every opportunity will be afforded the Station to investigate this disease in this State as it may best serve our interests. And in doing this the Station certainly can best afford to set an example by its method of dealing with its own stock.

In connection with the work of the Veterinarian I will state that hog cholera has caused severe ravages among the herds of swine in Indiana during 1895. Early in the year investigations on swine plague were begun on a herd in the suburbs of LaFayette. Since then the work has been prosecuted with considerable vigor. Late in the year a circular letter was sent to many swine raisers over the State calling for information on the disease, and replies have been received from about one hundred breeders and feeders, giving a large amount of important data concerning the prevalence of the disease and the methods

adopted for preventing it. These reports are based on observations on nearly 12,000 head of swine. The information received is of such importance that the veterinary department will prepare a bulletin which it is hoped will be printed for distribution early in 1896.

Indiana has very important market gardening interests in the southwestern section of the State. Many thousand acres of watermelons and muskmelons are each year grown in Sullivan, Knox, Gibson, Posey, Daviess, Pike and adjoining counties. Believing that valuable work may be done by the horticulturist in conducting a survey of this work, a circular letter was sent to about 1,500 persons in this region, asking a series of questions concerning the melon industry. The horticulturist has already made one trip into the melon district, at the request of the growers, in order to assist at preventing the ravages of disease among the vines. It is believed that the Horticultural Department can give valuable aid to the growers of this fruit by conducting experiments on preventing or controlling insect pests or plant diseases affecting the vines. Methods of culture and fertilization may also be studied here by the Station officers to the material benefit of the grower.

Among the lines of work desirable for the Station Horticulturist to follow is the improvement of some of our native wild American fruits. Among fruits of this class is the persimmon, which seems especially adapted to Central and Southern Indiana, where it grows wild in great profusion. This fruit varies greatly in quality and character, and merits the best attention of the work of the Horticulturist. Believing that important results in the way of improving this fruit may be secured, the Station Horticulturist is giving special attention to its improvement. Visits have been made to Southern Indiana, and a study of the tree and its fruit has been begun in localities where it exists in profusion and variety. The Station Chemist has analyses of the fruit in progress, and a bulletin, to be extensively illustrated, is all ready for the printer. It seems entirely reasonable to establish fixed varieties of this fruit and make the persimmon one of the commercially important and desirable crops of the State.

In the Chemical Department the soil investigations during the year have had greater importance than ever. In addition to a special study of the soil of our experimental field, based

on samples taken in 1888 and 1895, observations have been continued on the unproductive black soils of the State. In November a bulletin was published on these black soils, which has attracted more than common attention among our farmers. Numerous letters up to this writing have been received, expressing much appreciation of the practical importance and usefulness of this work. One well known farmer of the State informed the writer that had he had that bulletin at his command it would have saved him $100 in draining his black soil. The study of these unproductive black soils will be continued by the Chemist.

During the year two important investigations have been in progress in the Botanical Department, viz.: the culture of agricultural plants in pots and the experiments on corn smut. General field work by the Botanist has been materially curtailed, while the work of the laboratory and green-house has been strengthened. The systematic work with plants growing in pots in different types of soil and treated with different fertilizing materials can not help but yield important information of a character impossible to secure in the open field. Some of these results, it is hoped, will be suitable for publication the ensuing year. The corn smut investigations, referred to by the Botanist in his report, indicate that the spores of the smut will germinate immediately on ripening, and are consequently at once available for spreading the disease. It is also shown by the experiments in spraying that the smut may be greatly restricted, if not prevented, by the use of Bordeaux mixture. A new and promising line of investigation has been opened up in relation to preventing corn smut by spraying the plants. Heretofore all efforts have been restricted to the treatment of the seed.

In addition to the above experiment in the Botanical Department, the culture of mushrooms is receiving special attention. For several years a study of edible fungi has been made, both by the Chemical and Botanical departments, so that the practical culture of these is simply a continuation of work well established, although along new lines.

In both the Agricultural and Horticultural departments, for the third summer in succession, excessive drouth has materially interferred with the satisfactory growth of crops. Had we had a normal season in rainfall, the yield of crops on farm

and garden would not have been nearly a total loss, as they were in some cases. The entire oat crop was a failure, and no grain was secured. The corn crop suffered from lack of water when it needed it most. The orchard fruits fell from the trees in many instances before reaching maturity. The rainfall for the year was 11.76 inches short, or over 25 per cent.

Some feeding work with stock has been carried out. The calf feeding experiments have been continued during several months of the year, and much additional data has been secured. Feeding experiments with sheep have also been in progress. The writer has also carried on some investigations upon the udder of the cow in relation to milk yield. Records have been taken from many animals, and three days were spent with great profit with W. H. LaGrange & Son, of Franklin, and J. T. Polk, of Greenwood, who placed at my disposal their large herds of Holstein-Friesian and Jerseys, respectively.

This has been a year of unusual activity in experimental work and in the preparation of records. The prospects for 1896 are most encouraging.

The Station Staff has remained unchanged with the heads of the departments. The other members of the staff, excepting the Assistant Agriculturist, have also continued their relations with the Station. Mr. George R. Ives terminated his connection with the Station on April 1 to go into mercantile business. Mr. S. P. Carithers, a graduate of the School of Agriculture of the University in the class of '95, in June became Assistant Agriculturist, but resigned this position on September 7 to take up student work. For the balance of the year this position has been vacant.

No improvements of note have been made during the year. A small poultry house was built in the fall capable of accommodating 40 fowls. This was erected jointly from Station and University funds and will be used for instructional and experimental purposes. Some improvements must be made in 1896. Considerable new fencing should be erected, some of the buildings need painting badly, a new silo is a necessity, and the chemical laboratory should be removed to other quarters more healthful and commodious.

The Mailing List of the Station is constantly increasing in size. The following table shows the development of this list from January, 1893, to January, 1896. Editions of 13,000

copies are now being printed, and each year has seen an increase in the size of the editions struck off.

STATION MAILING LIST.

No. of Names on List of	Jan. 18, 1893.	Jan. 4, 1894.	Jan. 10. 1895.	Jan. 1, 1896.
People in Indiana	5,741	7,131	8,666	9,143
Indiana periodicals	635	668	653	625
People in other States	1,158	1,316	1,606	1,788
Periodicals in other States	83	91	86	92
Foreigners	26	51	61	77
Foreign periodicals	7	7	7	6
Total	7,650	9,264	11,079	11,731

The publications of the year have consisted of the annual report for 1894, four regular bulletins and eleven newspaper bulletins. These are as follows:

Seventh Annual Report for 1894, pp. 53.

Bulletin No. 54, Vol. VI, February, 1895, pp. 8, plates II, figure 1. New chemical apparatus.

Bulletin No. 55, Vol. VI, March, 1895, pp. 9–54, figure 1. Experiments with small fruits. Experiments with corn and oats. Sugar beets.

Bulletin No. 56, Vol. VI, August, 1895, pp. 55–80. Field experiments with wheat. Potato scab and its prevention.

Bulletin No. 57, Vol. 6, November, 1895, pp. 81–100, plates IV, figures 2–6. The improvement of unproductive black soils.

Newspaper Bulletin No. 8, May 8, 1895. Apple tree lice (Aphis mali, Fabr).

Newspaper Bulletin No. 9, May 14, 1895. The clay-backed cut worm (*Agrotis gladiaria*, Morrison).

Newspaper Bulletin No. 9, supplement, July 10, 1895. The chinch bug and its remedies.

Newspaper Bulletin No. 10, May 18, 1895. Late planting and replanting of corn.

Newspaper Bulletin No. 11, July 17, 1895. Burning fly-infested wheat stubble. Fall sowing of clover seed.

Newspaper Bulletin No. 12, September 12, 1895. Winter oats for the North.

Newspaper Bulletin No. 13, September 28, 1895. The feeding value of oats.

Newspaper Bulletin No. 14, October 14, 1895. Injury to corn fodder by field exposure.

Newspaper Bulletin No. 15, October 31, 1895. Hog cholera and its prevention.

Newspaper Bulletin No. 16, November 22, 1895. Treatment of corn smut.

Newspaper Bulletin No. 17, November 29, 1895. Protection of fruit trees from mice and rabbits.

It is proposed to publish the newspaper bulletins with much greater frequency than heretofore, issuing them about twice a month. These are short, one page leaflets, of about 450 words, and are intended to be of useful character. Editions of 600 are printed.

The number of regular bulletins published in 1895 fell materially below what it was desired to publish. This is not due to lack of material for publication, but to lack of money. The manuscript for three bulletins is now, January 1, in my hands awaiting publication. The general expenses of the Station are so great that ample funds are not at hand to print as freely as is desired. This Station receives no financial aid from the State. Could an appropriation be made to meet our printing bills it would materially aid in publishing more matter from the Station. During the ensuing year of 1896 it is hoped funds will be available to permit the printing of at least eight bulletins of importance.

Gifts, as indicated below, have been received during the year. In behalf of the Station the writer takes this opportunity to express our thanks for the numerous favors received from our friends:

United States Department of Agriculture, Washington, D. C. Books and pamphlets.

E. Sudendorf, Agent, Elgin, Ill., Wells, Richardson Co. Improved butter color.

L. B. Wombwell, Commissioner. Report Florida State Horticultural Society for 1894. Report Commissioner of Agriculture for 1894.

B. M. DeLong, Secretary. The Fourth Annual Report of the State Board of Horticulture for 1893-'94.

American Jersey Cattle Club, New York. Report of Valancey E. Fuller of the Jersey Herd of the World's Columbian Exposition, 1893.

W. S. Commons, Secretary, Centreville, Ind. Fourth Annual Report of the Indiana State Dairy Association for 1893

American Philosophical Society, Philadelphia. Annual proceedings.

Berndt Anderson, Secretary. Fifth Annual Report Minnesota State Dairy and Food Commissioner for 1893-'94.

W. Atlee Burpee, Philadelphia, Pa. 33 packets seed.

Peter McLean, Under Secretary of Agriculture, Brisbane, Queensland. Annual Report Department of Agriculture of Queensland for 1893 and 1894.

George McKerrow, Superintendent, Madison, Wis. Bulletins of Wisconsin Farmers' Institutes for 1893, 1894 and 1895.

German Kali Works, New York City. "Die Kalidungung," by Prof. Paul Maercker. 1893. "Experiments with Fertilizers upon Grapes," made at Liebfrauthal.

Dr. O. Comes, Portici, Italy. Hortus Botanicus Porticensis, 1894.

H. W. Buckbee, Rockford, Ill. Seeds for testing.

M. Crawford, Cuyahoga Falls, Ohio. Twelve plants strawberry seedlings, "Margaret."

J. W. Melson, Clifty, Ind. Strawberry plants.

William Trelease, Director Shaw Botanical Gardens, St. Louis, Mo. Sixth Annual Report Missouri Botanical Gardens for 1895.

F. D. Coburn, Secretary, Topeka, Kan. Vol. XIV Kansas State Board of Agriculture Report for 1893–94.

E. J. Hull, Olyphant, Pa. Hull's No. 4 strawberry plants.

W. R. Sessions, Secretary, Boston, Mass. Report Massachusetts State Board of Agriculture for 1894.

W. K. Boardman, Commissioner, Des Moines, Iowa. Reports Iowa State Dairy Commissioner for 1891, 1892, 1893, 1894.

Morrill & Morley, Benton Harbor, Mich. One knapsack sprayer.

Dr. A. R. Reynolds, Chicago, Ill. Annual Report Department of Health, City of Chicago, for 1894.

Dr. M. Hollrung, Germany. Sechster Berichte ueber die Thatigkeit der Dersunchsstation fur Nematodenvertilgung u. Pflanzensuchutz zu Halle, 1894.

William Fawcett, Director Public Gardens, Jamaica, West Indies. Bulletins of the Department.

Simeon J. Thompson, Chief, Indianapolis, Ind. Fourth and Fifth Biennial Reports, Department of Statistics.

Peter Henderson & Co., New York City. Winter vetch seed.

A. M. Brownlee, Secretary, Springfield, Ill. Reports for 1887, 1889, 1891, 1893, 1894 Illinois Live Stock Commissioner.

Herd Books Received.

Carl Freigau, Secretary, Dayton, Ohio. Vols. XVI and XVII Ohio Poland-China Record.

C. R. Thomas, Secretary, Independence, Mo. Vol. XIV American Hereford Record.

W. H. Caldwell, Secretary, Peterboro, N. H. January, April, July and October numbers Herd Register and Breeders' Journal of American Guernsey Cattle Club, 1895.

S. H. Todd, President, Wakefield, Ohio. Vol. V Todd's American Chester White Record, 1894.

Mortimer Levering, LaFayette, Ind. Vol. X American Shropshire Sheep Record.

Frederick L. Houghton, Secretary, Brattleboro, Vt. Vol. XIII Holstein-Friesian Herd Book.

A. J. Temple, Secretary, Cameron, Ill. Vol. I American Leicester Sheep Record.

F. M. Srout, Secretary, McLean, Ill. Vol. II Improved Essex Swine Record.

C. A. Chapman, Secretary, Middlebury, Vt. Vols. III and IV Vermont Merino Sheep Breeders' Association.

H. B. Richards, Secretary, Easton, Pa. Vols. I to IV Herd Book Dutch Belted Cattle Association.

N. R. Pike, Secretary, Winslow, Me. Vols. I, IV, V, VI, VII Maine Jersey Cattle Club Herd Book.

C. C. Johnson, Secretary, Canonsburg, Pa. Vols. I, II, III, IV, V National Delaine-Merino Sheep Breeders' Association.

The publishers have kindly sent the following periodicals to the library for the year, for which the Station expresses especial appreciation:

Agricultural Gazette of New South Wales	Sidney, Australia.
Agricultural Epitomist	Indianapolis.
American Creamery	Chicago, Ill.
Agricultural South	Atlanta, Ga.
Agricultural Student	Columbus, Ohio.
American Cultivator and Poultry Keeper	Los Angeles, Cal.
American Fertilizer	Philadelphia, Pa.
American Florist	Chicago, Ill.
American Grange Bulletin	Cincinnati, Ohio.
American Horticulturist	Wichita, Kan.
American Sheep Breeder and Wool Grower	Chicago, Ill.
Baltimore Sun (weekly)	Baltimore, Md.
Breeders' Gazette	Chicago, Ill.
Creamery Journal	Waterloo, Iowa.
Drainage Journal	Indianapolis.
Elgin Dairy Report	Elgin, Ill.
Experiment Station Record	Washington, D. C.
Farm and Dairy	Ames, Iowa.
Farm and Fireside	Springfield, Ohio.
Farm and Home	Chicago, Ill.
Farm, Field and Fireside	Chicago, Ill.
Farm Journal	Philadelphia, Pa.
Farm Poultry	Boston, Mass.
Farmers' Advocate	London, Ontario, Can.
Farmers' Call	Quincy, Ill.
Farmers' Guide and Home Companion	Huntington.
Farmers' Home	Dayton, Ohio.
Farmers' Review	Chicago, Ill.
Field and Farm	Denver, Colo.
Grange Visitor	Lansing, Mich.
Hoard's Dairyman	Fort Atkinson, Wis.
Holstein-Friesian Register	Brattleboro, Vt.
Home and Farm	Louisville, Ky.
Home Journal	LaFayette.
Hospodar	Omaha, Neb.

Indiana Farmer	Indianapolis.
Industrial American	Lexington, Ky.
Industrialist	Manhattan, Kan.
Iowa Homestead	Des Moines, Iowa.
Jersey Bulletin	Indianapolis.
Journal of Agriculture	St. Louis, Mo.
Kansas Farmer	Topeka, Kan.
LaFayette Commercial Gazette	LaFayette.
Louisiana Planter and Sugar Manufacturer	New Orleans, La.
Mennonitische Rundschau	Elkhart.
Michigan Farmer	Detroit, Mich.
Mirror and Farmer	Manchester, N. H.
Montana Fruit Grower	Missoula, Mont.
National Dairyman	Kansas City, Mo.
National Stockman and Farmer	Pittsburg, Pa.
Nebraska Farmer	Lincoln, Neb.
New England Farmer	Boston, Mass.
Ohio Farmer	Cleveland, Ohio.
Orange Judd Farmer	Chicago, Ill.
Oregon Agriculturist	Portland, Ore.
Pacific Coast Dairyman	Tacoma, Wash.
Pacific Rural Press	San Francisco, Cal.
Practical Dairyman	Chatham, N. Y.
Practical Farmer	Philadelphia, Pa.
Prime's Crop Bulletin	Dwight, Ill.
Progressive South	Richmond, Va.
Rural Northwest	Portland, Ore.
Salt Lake Herald	Salt Lake, Utah.
Silent Hoosier	Indianapolis.
Southern Cultivator and Dixie Farmer	Atlanta, Ga.
Southern States	Baltimore, Md.
Success with Flowers	West Grove, Pa.
Sugar Beet	Philadelphia, Pa.
Wallace's Farmer and Stockman	Des Moines, Iowa.
Wayne Farmer	Hagerstown.
Weather and Crops	Chicago, Ill.
Western Soil Culture	Minneapolis, Minn.
Western Swineherd	Geneseo, Ill.
Wisconsin Agriculturist	Racine, Wis.

I herewith submit the annual reports of the several departments of the Station, as a part of this, the Annual Report of the Experiment Station for 1895.

Respectfully submitted,

C. S. PLUMB,
Director.

REPORT OF THE HORTICULTURAL DEPARTMENT.

To C. S. Plumb, Director:

SIR—The work of this department during the past year has progressed as rapidly as the conditions would permit. The exceedingly dry weather, coming so early in the season, and continuing until the close, cut short much of the experimental work. The average monthly rainfall for the six months including March and August, for fifteen years previous to 1895, was 3.69 inches, while that for the corresponding months in 1895 was only 1.92 inches, making a monthly deficiency for the six growing months of 1.77 inches, or a total deficiency for the year up to October 31 of 14.10 inches. This lack of rain fall prevented in a measure the good results usually obtained by cultivation, as there was little capillary water in the soil at the beginning of spring. The late spring frosts destroyed almost the entire crop of small fruits, so that no reliable results in varietal testing were obtained. Most of the orchard fruits, however, such as apples, pears, plums and cherries, bore good crops. There are now growing on the experimental grounds 93 varieties of apples, 27 varieties of pears, 33 varieties of plums and 25 varieties of cherries. The Russian varieties of apples, as a rule, have not given the best of satisfaction, owing mainly to the fact that the varieties planted nine years ago were adapted to a colder climate than ours. This causes them to ripen much earlier in the season than is desirable. It is the intention to top-work the most of these trees the coming season with varieties which are better suited to our climate.

THE RELATION OF BARN MANURES TO SOIL TEMPERATURE.

This was an experiment to determine the influence of barn manure on the temperature of the soil as affecting the germination of seeds.

In the early part of April two plats were prepared exactly alike in every particular, except one received a dressing of

fresh barn manure, at the rate of 25 tons per acre, which was plowed under just before sowing the seed. Soil thermometers were inserted to a depth of 4 inches in two sets in each plat. Readings were made at 7 A. M. and 2 P. M. every day for ten days. The average results, at the end of this time, were as follows:

On the manured plat	70.6
On the unmanured plat	65.7

A difference of nearly 5 degrees in favor of the manured plat, which would, in most cases, be sufficient to account for the greater per cent. of germination as was shown in this experiment.

SECOND CROP OF SEED POTATOES.

In order to test the question of superior qualities of second crop potatoes for planting purposes a barrel of these potatoes was procured from John C. Pearce & Co., of Louisville, Ky., and planted in connection with home-grown potatoes. The tubers were cut in each case to two-eye pieces and planted 18 inches apart in trenches. Result: The "second crop" showed through the ground three days before the northern grown seed, and the vines were ripe ten days before the others. On digging the crop it was found that the "second crop" produced 12 per cent. more marketable potatoes per acre than the home-grown seed. This would seem to indicate that there really is a difference in favor of the second crop potatoes for seed.

Another experiment which I believe to be of much importance to the people of southern Indiana especially, has been in progress for two years. This has for its object the improvement, through cross-fertilization and selection, of our native persimmon and papaw. This work has been placed in the hands of Mr. O. M. Hadley, of Danville, Ind., a former student of the University, who is now in charge of the sub-station at Danville. A preliminary bulletin on the subject will soon be published giving the results obtained up to date.

The work of the other three sub-stations has consisted mainly of testing new varieties of fruits as they have been sent to us by the originators.

INSECTS OF THE YEAR.

The climatic conditions of the past season have been especially favorable for the development of some species of our injurious insects. Among those about which inquiries were most frequently received were the apple tree plant louse (*Aphis mali*), several species of cut worms, the most common of which was the clay-backed cut worm (*Agrotis gladiaria*), the fruit bark beetle (*Scolytus rugulosus*), the Hessian fly (*Cecidomyia destructor*) the potato stalk borer (*Trichobaris trinotata*) and the chinch bug (*Blissus leucopterus*). The chinch bug was more destructive than it has been before in the last decade, and unfortunately it seems to be comparatively free from natural enemies, either insects or birds. Our efforts to inoculate the bugs with the white fungus disease were not as successful as it was expected they would be, owing mainly to the atmospheric conditions which existed at the time, viz.: very hot and dry. These conditions are most favorable for the rapid development of the bugs, but least favorable for the propagation of the fungus.

Newspaper bulletins have been issued during the year concerning the management of the apple-tree plant louse, the clay-backed cut worm and the protection of fruit trees from mice and rabbits.

Respectfully submitted,

J. TROOP,
Horticulturist.

REPORT OF THE BOTANICAL DEPARTMENT.

To C. S. Plumb, Director:

SIR—The work in the Botanical Department during the year 1895 has followed the general trend of that of previous years. The most conspicuous work of the year, especially in securing data that lead to a better understanding of important matters of practical bearing, has been the study of corn smut, its mode of natural infection and the means to hold it in check, together with the study of weeds, especially those of recent introduction into the State. The examination of the first subject has led to important deductions that can not but be of the highest importance to every farmer who raises corn. The matter will be referred to again in this report.

In this connection it may be well to speak of the method pursued by the department in gathering and disseminating botanical information. A very large number of experiments are performed each year. These are distributed among several subjects, as material, time and assistance may allow. Sometimes the experiments of a single year settle a disputed or obscure question beyond reasonable doubt, and the data are at once ready for publication. More often, however, the questions involved are too complicated or too baffling to be so rapidly disposed of. It not infrequently happens that through unforeseen events, especially by the accidents of the weather, well-planned experiments afford but imperfect or unreliable data, and the subject must be held in hand for another year, or until more satisfactory experimental results can be secured. As work progresses and the full bearing of the subject is better understood, new or collateral questions arise which must first be answered in order to speak with confidence; and thus

in various ways an investigation may be prolonged for several years before it is in shape to be presented to the public. It thus comes about that only a small part of the results of a year are printed and distributed the same year in which they are secured.

The cultivator has many ways by which to obtain knowledge of the accepted facts pertaining to his calling, such as books, the agricultural press and other class journals, institutes, government bulletins, etc., so that the State experiment station can not better serve the interest of its patrons than by devoting some of its resources to attacking heretofore unsolved problems, and doing the work so thoroughly that a permanent addition is made to fundamental knowledge on which to base broad generalizations to serve practical ends. Instances of such work already issued from this department may be cited. The investigation of potato scab was begun in 1889 and prosecuted until the present year, when in August a bulletin was issued giving a history of the investigation and an account of the disease and its treatment. It is now one of the best understood and most thoroughly and readily controllable of all plant diseases, a result largely due to the work initiated or carried out by this department. The bacteriosis of carnations was first recognized in this department in 1888, and the work of its investigation wholly carried out here. It has been studied until the present time, and the results are now put into the form of a bulletin, which is to be issued early in the coming year. In both cases the value of the work to the cultivator has not been sequestered in the dark pigeon-holes of the Station records during these years, but has been given out orally to societies and upon suitable occasions as the work developed, and has been so much appreciated that progressive cultivators have already modified their methods in accordance with the suggestions. Other instances of the progress of work in the department might be cited, but these suffice to indicate the methods pursued.

Potatoes. The proper and economical distribution of water to growing crops is a most important matter. The use of subirrigating tiles or other conduits to supply moisture to the roots of crops in dry weather, and to rapidly remove superfluous moisture in wet weather appears to be an ideal system, if it can

be brought into the range of profitable and convenient application. There are many ways which suggest themselves, but the one best way to be eventually adopted can not yet be foretold. In the meantime many experiments are required.

A preliminary trial was made with a crop of potatoes in 1894, and carried out the present year in a more complete manner. The ground was laid in November, 1893, with three-inch tiling, ten inches below the surface and in parallel lines three feet apart. In dry weather one end of the line of tiling was closed and water run in, which passed out into the soil and supplied the roots with moisture. The difference between the sub-irrigated and the non-irrigated plats was evident to the eye almost as soon as the potatoes appeared above the surface of the soil. On June 24 the average height of the plants in the sub-irrigated plat exceeded the others by three inches. When the crop was gathered, the merchantable potatoes showed a gain of nearly 35 per cent. due to the use of water, a gain wholly brought about by the increase in the size of the tubers, as no more tubers were set in the hills of one plat than of the other. This is a notable gain, but its profit will depend upon the amount to be deducted to cover the expense of water used, extra labor and cost of placing tiles. Data on all these points were secured and will be discussed in detail at some other time. It need only be added here that the trials so far made are promising of eventual practical application.

Spraying potatoes with Bordeaux mixture was again tried this season. The results of this line of work will be collated after a time. It need only be said here that the outlook appears to favor the application of this spraying material, for the purpose of both holding diseases in check and increasing the natural growth.

Some few trials to answer purely physiological queries were made this year, such as the difference in yield between tubers of greater or less specific gravity, between rough and smooth tubers and between large and small tubers. The last was tried with about thirty different varieties. Also some trials were made, mostly done in the vegetation house, as to the relation, if any, of the percentage of moisture in the soil to the number of shoots that start from seed-tubers. Most of the work in

the line of physiological inquiry so far contemplated has, however, been performed in past seasons, and the large accumulation of data now awaits suitable study and arrangement, when it will be presented in form of bulletins, and be more fully available as guide to agricultural treatment of this important crop.

During the year a bulletin on "Potato Scab and its Prevention" was issued, being the second half of No. 56, dated August, 1895. The corrosive sublimate treatment of the seed tubers there recommended is found to be a thoroughly efficient and economical method of preventing the appearance of this injury in the crop, and one likely to be adopted by cultivators who desire superior products and look carefully after the margin of profit.

Oats. Some tests were instituted to ascertain if climate has any effect upon the abundance of smut, but no decisive results have yet been attained.

Corn. In 1891 experiments were begun looking toward a better understanding of the troublesome disease of smut, which in Indiana does much harm to the corn crop. The results of that year were interesting from a purely scientific standpoint, but gave so little promise for finally working out any method for practical control of the disease that the line of inquiry was not pursued. Through the earnest suggestion of my colleague, Professor W. C. Latta, whose intimate acquaintance with the farmers and farming condition of the State has given him exceptional opportunity to form an accurate opinion of the need of such work, the study of corn smut was again taken up. At first it was only thought feasible to collate the literature with a view to publish an account of the subject as now understood, so far as it would be of interest to the farming community. In the last year or two there have been an unusual number of inquiries in the agricultural press regarding the subject, showing much need of more accurate and substantial information. It was not long, however, before a line of promising experimental inquiry opened out, and results of far more value than anticipated have been obtained.

The work in corn smut this year has included an examination of the mode of infection of the corn plant, of the transfer of the fungus from plant to plant and of the efficiency of the spraying with fungicides. It is especially important to know

that the spores, which are formed in enormous numbers in every swollen mass of the fungus, are capable of germination immediately upon ripening, requiring no resting period, and therefore are at once available in spreading the disease. The general opinion seems to be that these spore masses are harmless until after having passed a winter, an opinion that is shown to be erroneous. Although the spores grow at once, when brought into suitable conditions, yet it is found that they will keep their germinating power for more than a year. When these facts are associated with the further fact, inferentially rather than directly deduced from our experiments, that the corn plant is not infected through the seed, as in the well-known case of oats, but at any point of the growing plant where the sporidia of the smut may find lodgment, it will be seen that the most effective procedure toward getting rid of corn smut in a region, will be to gather and destroy (burn or deeply bury) the smut before the smut masses burst and scatter the spores. This necessitates going through the corn fields two or more times during the season, to collect the smut before it has fully ripened. The above facts have been briefly set forth in a newspaper bulletin issued November 22, 1895. This will eventually be elaborated, together with other related matters, in a larger bulletin.

The experiments of the year resulted in the first successful spraying to prevent corn smut yet reported for this country, and, so far as the writer knows, the first obtained anywhere. The fungicides used were Bordeaux mixture and ammoniacal copper carbonate, the former being the more efficient. Plats of considerable size were selected out of a large field. In all, eleven sprayings were given. The smutted stocks on the untreated portion amounted to 13⅓ per cent.; on the part treated with ammoniacal copper carbonate, nearly 7 per cent., and on the part treated with Bordeaux mixture less than 4 per cent. This gives a difference of nearly 10 per cent. in favor of the application of Bordeaux mixture. In looking over the season's record it is easy to see that in all probability the appearance of smut could have been entirely prevented by a more rigid use of the latter fungicide. During the progress of the work many interesting and valuable facts were ascertained, which can not be even mentioned in this place. A paper upon some features of the work was presented before the Indiana

Academy of Sciences at its annual meeting in Indianapolis, December 27, 1895, by the assistant botanist of the department, and will be published in the proceedings of that body. Whether the spraying of field corn to prevent smut ever becomes an economical procedure or not, the results of the experiments, when reported in detail, can not fail to be of lasting service to the farming community.

Vegetation House. The work in the Vegetation House this season was especially successful. This kind of experimental research requires an unusual amount of labor and close attention, and, although much has been accomplished, yet for want of enough assistance the full capacity of the new Vegetation House has not been reached.

The principal part of the season's work was devoted to a study of the response of field crops (chiefly oats) to the application of several mineral fertilizers. The conditions to be considered in such a study are very complicated, and no limited work can be expected to result in elucidating facts of general value unless restricted to some one feature of the inquiry. In accordance with this opinion, an answer was sought for the question, What is primarily the most important food constituent required for a field crop (oats) in this vicinity? The three chief mineral constituents of plant food, potash, nitrogen and phosphoric acid, were used in a single form for each and applied in both small and large amounts and in various combinations with each other. Three kinds of soil were used: the loam which forms the general surface soil of the Experimental Farm, the clay soil found a mile north of the Experimental Farm, and clay subsoil, taken from below the level of tillage.

The general plan was to make each test in duplicate and to make as many combinations of the fertilizers as convenient. The several experiments are too long and too filled with necessary details to be given here, and only brief reference can be attempted. In one experiment 36 cans were used, all prepared and planted at the same time; in another 64 cans were used. Photographs were taken at different stages of growth. Most careful record was made of the rate of growth and the amount of yield. The yield was reckoned on the weight of the straw and the weight and size of the grain. The most marked increase in yield was obtained with the phosphoric acid (applied

in bone meal), especially in clay soil, the effect being greater proportionately on the straw than on the grain. On the black loam the increase in yield was un xpectedly small, and in some cases the application of single fertilizers brought about a decrease, although in all cases, whether the total yield was more or less, the size of the grain was increased, as shown by the weight per 100 kernels. The value of this series of data is believed to be considerable, but it can not be condensed into statements sufficiently brief to find place here.

Besides the series in oats, referred to above, less extensive experiments were carried out with corn, potatoes, purslane and other plants. Winter wheat, started the preceding fall in cans, was only partly carried through the winter owing to soil in the cans freezing too deeply, and the contemplated experiments with it were abandoned. The experience, however, has shown, it is thought, how to guard against the accident, and another set of experiments with winter wheat has been started for the coming season.

Weeds. The bulletin on prickly lettuce published in 1894 aroused great interest in this and other weeds, and has lead to deserved agitation of the whole weed question. As there appeared to be much need of more accurate knowledge of the weeds and their treatment, the department has given considerable time to the subject. Record of all new stations reported for the prickly lettuce has been kept in order to keep trace of the continued spread of the weed through the State. Some other especially noxious weeds, comparatively recent immigrants, such as the buffalo-bur (*Solanum rostratum*), horse nettle (*Solanum Carolinense*), spiny pig weed (*Amaranthus spinosus*) and spiny cocklebur (*Xanthium spinosum*) have been under surveillance, and especially the Russian thistle. The last has invaded our borders, having extended across the northern end of the State and started across the eastern border at one locality. That it will eventually find its way over the whole State, to the great detriment of agricultural interests, can not be doubted, unless radical measures are taken to stop its progress. This is a case in which a suitable State weed law could be made serviceable and prove of immense aid to those persons who are willing to take an active part in suppressing and controlling noxious weeds. Laws to be effective should be directed against certain weeds, whose modes of distribution are

well understood, so that the end sought can be attained with certainty. Never in the history of the State has there been a more auspicious time for the enactment of laws for this purpose or one when they were more needed. The agitation about the Russian thistle has directed the attention of all classes of the community toward the subject of weeds, while the present rapid invasion of the State by some of the most obtrusively noxious of all known weeds will especially enlist the co-operation of persons to whom will fall the duty of making active warfare upon them.

Another phase of the weed question was also accorded especial attention. Several years ago a study of the peculiarities in the germination of cockle bur seeds was begun, and the fact established that the two seeds in each bur react differently under like conditions for germination. It was not until the spring of the present year that a clue to the cause of this unique phenomenon was found. A systematic examination of the matter was now entered upon, and with very satisfactory results, as will be seen when the details are displayed in a bulletin. A portion of the data was used in a paper read before the Society for the Promotion of Agricultural Science at its annual August meeting in Springfield, entitled, "Delayed Germination of Cockle-Bur and Other Seeds."

The inquiry has brought out some other facts of a most practical character, which have their application in any rational method of controlling this weed pest.

Miscellaneous. Other subjects have engaged the attention of the Department, which do not call for special mention. The efficiency of the Department has been greatly increased through the appointment of Mr. William Stuart, of the University of Vermont, as Assistant Botanist. His fidelity, mature judgment and keen insight have materially aided in turning out more and better results, and especially so with difficult investigations.

Respectfully submitted,

J. C. ARTHUR,
Botanist.

REPORT OF THE CHEMICAL DEPARTMENT.

To C. S. Plumb, Director:

SIR—The following is a summary of the work of the Chemical Department for the year 1895:

LABORATORY APPLIANCES.

Two special machines have been devised for the purpose of conducting certain laboratory operations under more uniform conditions, and at the same time reducing the labor and time required for treatment with solvents and for precipitation. These machines are described in detail in Bulletin No. 54.

SUGAR BEETS.

The work on sugar beets was confined to the Station farm, as the sugar situation was such that it was not deemed advisable to conduct the work on a more extended scale. The season was unfavorable, owing to the severe drouth. The results will appear in connection with a bulletin from the Horticultural Department.

FORMS OF NITROGEN FOR WHEAT.

The work of this year on the subject was abandoned before harvest, as the drouth was so severe as to practically destroy the crop.

UNPRODUCTIVE BLACK SOILS.

Work on the subject was commenced in the spring of 1892 and experiments in Tippecanoe and White counties were conducted with a view to the improvement of such lands. The results of the work have been published in bulletin No.

57. Simple, cheap and efficient means for the temporary improvement of such lands have been devised, and the need of efficient, and in many cases, special drainage is shown to be the cause of the unproductiveness of these lands. The results of this work seem to be highly appreciated by the farmers in the sections of the State where such lands are found.

Examination of Field Plats.

When the field plats of the Station were laid out in 1888, samples of the soil of each plat were carefully drawn and preserved. In the spring of 1895 samples were again drawn from these plats, and the work of making examination of these soils is in progress. These examinations are not perfunctory soil analyses, but special investigations with a view of improving the methods of examination of soils that have been under cultivation for a definite number of years, during which period an accurate account has been kept of the materials applied to the land and of the crops removed.

The question of determining the available plant food in a soil that has been under cultivation for a considerable number of years, is one of much importance. The methods of soil analysis now in vogue, do not seem suitable for the purpose, and the investigation in question is undertaken with a view of developing more suitable methods At the same time the results of the work are available in considering the results of our systematic work on these plats.

Feeding Material.

There is a strong demand for better methods for the examination of feeding stuffs. The methods in use hardly draw any distinction between a coarse feed and the manure resulting from feeding it. An extended examination of a sample of timothy hay and the manure produced by feeding the same was undertaken, and analyses made both by the customary methods and by more extended methods. The results by the special methods, show at a glance the effect of the digestive processes to which the manure had been subjected. While such investigations are very tedious and seldom undertaken,

it is to the results of such work that we must look if we are to find a means of arriving at the nutritive value of cattle food by means of chemical examinations. The results promise to be of especial value in the examination of side products which have been subject to fermentation.

Weeds.

In 1892 we made analyses of the feeding and fertilizing value of purslane. During the year further samples were collected during the severe drought. Hog raisers are interested in the plant as a possible supply of succulent food during dry seasons.

Persimmons.

An extended examination of the fruit of the persimmons (six varieties) is in progress. This work is conducted in connection with the investigation of the subject by the Horticultural Department. No analysis of the fruit can be found in any available literature. The raising of persimmons for the market has assumed considerable importance in certain sections of the State.

Miscellaneous.

The customary number of miscellaneous examinations have been made during the year. Among them may be mentioned a flint from Fountain County used for road making, hog powder, American "tripoli," corn cob ash, retreated rancid butter and bitumen.

Bitumen is found in several counties impregnating soil and muck, but none of the samples sent to us contain enough bitumen to be considered of commercial importance.

Correspondence.

The number of letters relating to subjects connected with the chemical work of the station is increasing each year. It is also gratifying to note that, while a few years ago our correspondents asked indefinite questions on all sorts of subjects, the recent requests are for specific information on questions of fundamental importance in practical agriculture.

Institute Work.

The demand for the Chemist to address farmers' institutes is increasing, and a larger number of addresses of this sort has been delivered this year than ever before. Farmers appreciate this part of the work, and the Station has an opportunity of gaining information in regard to agricultural interests and needs of different portions of the State that it would be difficult to obtain in any other way.

Equipment.

The equipment of the laboratory has been well maintained. A considerable loss of time and material results from the restricted quarters in which the work is conducted, and it is hoped that more commodious and safer quarters may be available before the end of the next year.

Mr. J. M. Barrett has acted as Assistant Chemist during the year, and his services have been highly satisfactory.

Very respectfully submitted,

H. A. HUSTON,
Chemist.

REPORT OF THE VETERINARY DEPARTMENT.

To C. S. Plumb, Director:

SIR—During the early part of the year the work was largely directed toward the study of antiseptics and antiseptic methods of treating wounds. Sixty drugs and preparations were tested by laboratory methods to determine at what strength they possessed antiseptic power. The detailed results show that only a few of the many drugs used as antiseptics really possess germicidal properties, and some of these only at such a degree of concentration that they would be harmful to the tissues to which they might be applied. Many of them possess the power of so retarding growth that for all practical purposes they are antiseptic. The results of the laboratory experiments were carried out in the clinic during the whole year. A little over three hundred wounds were examined and the septic organism isolated. These were found to be *Staphylococcus pyogens albus*, *S. pyogens aurens; S. pyogens citrens; Streptococcus pyogens* and *Bacillis pyocyanus*, *S. pyogens albus* being in about 95 per cent. of the cases examined. The body was also examined, for the presence of germs, before operations and again after, in those cases where antiseptic methods were employed. The results in favor of the use of antiseptics is very marked.

In July an opportunity presented itself for the study of *Milk-sickness.* This disease has a very considerable historic interest, but is not so destructive to stock interests or human life as in the pioneer days. It is still to be found in numerous places along the Wabash and White rivers. In many respects the disease resembles anthrax but differs from that disease in some of its features. As the disease is indigenous to certain woods pastures in the vicinity of the Station, an attempt will be made to complete the study during the coming season.

In November the Station herd was again subjected to the tuberculin test, with the results that five of the twenty-eight head of cattle gave a positive reaction and two others a suspicious rise of temperature. The five head were slaughtered and tuberculosis found to be present in every case.

Hog cholera has undoubtedly a greater loss than any other disease in the State and is most deserving of continuous study. The loss for the present year will probably exceed $2,000,000. No doubt but that a very large per cent. of this loss could have been averted had proper care been exercised in handling. Data collected from a large number of men who breed swine for breeding purposes indicates that their loss is far less than the farmers who handle them as producers of pork. Their advantage seems to be due to the extra care in feeding and hygienic surroundings.

Two poultry diseases have received a preliminary study. The first is locally known as "sore head" and the latter is a liver disease among turkeys. These are the same diseases recently reported upon in a bulletin from the Bureau of Animal Industry. Data has been obtained and work completed available for bulletins upon antiseptics, surgical treatment of wounds, tuberculosis, hog cholera and Texas itch.

Respectfully submitted,

ARVILL W. BITTING,
Veterinarian.

REPORT OF THE AGRICULTURAL DEPARTMENT.

To C. S. Plumb, Director:

SIR—The work of this Department for the year 1895 has been mainly a continuation of lines of investigation previously entered upon.

A drouth which was severe and almost continuous up to the first of July compelled an abandonment, for the season, of (1) all experiments with oats; (2) the experiment with early and late harvesting of wheat; (3) the experiments with varieties of corn, thick and thin and early and late planting of corn, and test to determine the number of days required to mature corn. Indeed, the growth of grains and grasses was so seriously interfered with as to greatly reduce the practical value of the experiments with these crops.

The results of the past season are given below, being incorporated with the results of previous years.

I. EXPERIMENTS WITH VARIETIES.

1. *Wheat*—Number of varieties grown in 1895, 37; time under trial, 1 to 12 years; average yields range from 17 to 29 bushels; yields in 1895 range from 13 to 29 bushels; more promising varieties, Jones and winter fife, Rudy, Velvet chaff.

2 *Grasses*—The grasses and clovers under trial are given in the accompanying table. Nos. 1 to 6 inclusive were sown in the spring of 1893. The rest were sown in the spring of 1894. The first crop in every case was harvested the year succeeding the sowing. The plats were about one-fifteenth acre each in size. The yields per acre of cured hay for each year are as follows:

YIELDS OF GRASS PLATS PER ACRE.

No.	Variety.	Pounds Hay.	
		1894.	1895.
1	Alfalfa	3,080	4,197*
2	Alsike	3,582	1,318*
3	Crimson clover	3,223	1,574*
4	Timothy (one-half); Mammoth clover (one-half)	3,152	2,894*
5	Meadow fescue	2,435	745*
6	Orchard grass (one-half); common clover (one-half)	3,297	2,851*
7	Italian rye grass		1,647*
8	Red-top (*Agrostis vulgaris*)		888
9	English rye grass		516
10	*Alopecurus pratensis*		179
11	*Avena elatior*		143

*Aggregate of two cuttings.

The alfalfa gave much better results than any of the clovers or grasses in 1895. The crimson clover has largely given place to other clovers which made up the bulk of the yield on plat 3 in 1895. The low yield of plat 5 is due to the fact that there was practically no meadow fescue in the seed that was purchased under that name, but comparatively worthless sorts instead. The English rye grass produces a very short, sparse growth. The Italian rye grass starts quickly from the seed and yields well, but is killed by severe winters. The redtop did quite well considering the exceptionally dry season, and the water loving habit of this grass. *Alopecurus pratensis* and *Avena elatior* can not be recommended on what they have done at this Station.

3. *Lathyrus sylvestris.* This forage plant was sown in the spring of 1894. It produced a growth only about six inches high the first season and not more than a foot high in 1895. It sends a tap root deep into the soil and endures drouth remarkably well. It may have some value in renewing light, sandy and greatly exhausted soils if left to grow for several years. Its extremely slow germination and slight growth unfit it for use as a forage or pasture crop.

II. Thick and Thin Sowing of Wheat.

Quantity of seed sown, 2 to 10 pecks per acre; time under trial, 11 years; range of average yields, 23 to 30 bushels; range of yields in 1895, 18 to 21 bushels; highest average yield produced from 8 pecks to the acre; lowest average from 2 pecks per acre.

III. Early and Late Sowing of Wheat.

Range of dates previous to the fall of 1893, September 18 to October 18; range of dates since the fall of 1893, September 13 to October 11; time under trial, 7 years; range of average yields, 23 to 30 bushels; range of yields in 1895, 7 to 19 bushels; highest average yield from sowing September 18 to 20.

IV. Deep and Shallow Culture of Corn.

Time under trial, 7 years; range in depth of cultivation, 1 to 4 inches; average yield from cultivation 1 inch deep, 43 bushels; from 2 inches deep, 42 bushels; from 3 inches deep, 39 bushels; from 4 inches deep (1894 and 1895 only), 20 bushels. The low average yields are due to the drouths in 1893, 1894 and 1895. The exceptionally low yield from cultivation 4 inches deep is due chiefly to the fact that this depth has been tested but two seasons, both of which have been very dry.

V. Experiments With Different Corn Cultivators.

Number of implements under trial in 1895, 6; time under trial, 2 to 8 years. The average yields obtained with the several implements and the time each has been under trial are as follows: *Corn plow*, 7 years, 51 bushels; *Spring tooth cultivator*, 7 years, 53 bushels; *Gopher* (a cultivator with flat blades which shaves the surface), 6 years, 49 bushels; *Tower's cultivator* (a shallow working implement), 3 years, 45 bushels; *Planet Jr.* (a 1 horse cultivator), 4 years, 46 bushels; *Breed's weeder* (in connection with a 1-horse harrow, the former being used early

and the latter late in the season), 2 years, 39 bushels. Owing to the fact that the last three years have been unusually dry the above comparisons are unfavorable to those implements which have been under trial the shortest time. The results obtained in 1895 are therefore given separately, below, in the order of arrangement of plats in the field.

Spring tooth cultivator	41.5	bushels.
Breed's weeder and harrow	42.7	"
Gopher	39.8	"
Spring tooth (same as first)	42.9	"
Tower's cultivator	37.6	"
Corn plow	37.1	"
Planet Jr.	38.2	"
Spring tooth (same as first)	47.1	"

VI. Effects of Previous Manuring on Yield of Corn.

The ground devoted to this experiment has been continuously in corn since 1880. In 1883 and 1884 fresh horse manure was applied to alternate plats, amounting for the two years to about fifty tons per acre. No manure has been used on this ground before or since the two years named. A comparison of the yields of the manured and unmanured plats shows an average increase in yield per acre from the manured to be over ten bushels. The *aggregate increase* from the manure in twelve crops is 123 bushels to the acre. The increase in 1895 is nearly four bushels to the acre, showing the manure is not yet exhausted. The crop of 1887 was almost an absolute failure owing to drouth, and is not included in the figures given above.

VII. Effect of Rotative Cropping and Continuous Grain Growing on Yield.

Corn, wheat and oats have been grown *continuously* or *in alternation* one with another, on a series of plats (H) for fifteen years. The same crops, *in rotation with grass and clover*, have been grown for the same time on adjacent series (F). The grain, stalks, straw and hay have been regularly removed, and no manure or fertilizer has been used on either series since the experiment was begun. The average yield of both series and the increase per acre from rotation for the last nine years are shown in the accompanying table.

YIELDS FROM ROTATIVE AND ALL-GRAIN SERIES.

	Corn.
Series F, crops in rotation	30 bushels.
Series H, grain crops only	24 "
Gain from rotation	6 "
	Oats.
Series F, rotation	*34 bushels.
Series H, grain only	*27 "
Gain from rotation	7 "
	Wheat.
Series F, rotation	20 bushels.
Series H, grain only	13 "
Gain from rotation	7 "

The average per cent. of gain in yield of the several crops from rotation are: Corn, 22 per cent.; oats, 19 per cent.; wheat, 50 per cent.

VIII. HEAVY AND LIGHT APPLICATIONS OF MANURE AND FERTILIZER.

This experiment was begun in 1889, and has been carried on continuously ever since. The plan of the experiment includes a variety of crops to be grown in shorter or longer rotations, and also the continuous growing of wheat and corn, each by itself. Certain plats in each of the several series receive applications, separately, of manure and fertilizer sufficient to produce full crops. Other plats receive lighter applications ranging from one-half to three-fourths of a full dose.

Oft recurring and severe drouths have thus far greatly interfered with this work, in some cases almost preventing the fertilization from having any beneficial effect on yield. The lighter applications of manure have generally proved profitable.

Heavy manuring has proved either unprofitable (in a few instances) or less profitable than *light* manuring. The lighter applications of fertilizer have in some instances, proved profitable, while the heavy applications, though sometimes having a marked effect, have generally proved unprofitable. In explanation of the above it may be said that the soil of the Station farm is still fairly fertile, producing in favorable seasons without manure or fertilizer about twenty bushels of wheat, and about forty bushels of corn.

* This does not include the crop of 1885, which was mown for hay.

IX. Coöperative Test of Varieties of Wheat.

This experiment has been conducted the last two years Its purpose is to determine the adaptation of a few leading varieties of wheat to different sections of the State. The results for the two years are given in the table which follows:

YIELD OF WHEAT IN DIFFERENT COUNTIES.

Variety.	Tippecanoe.	Jefferson.	*Madison.	Whitley.	Dekalb.	Average Yield and Weight.
Red Clawson	36.31	36.85	25.74	35.06	30.01	32.79
Pounds per bushel	58.31	62.75	55.5	60.12	57	58.76
Jones' Fife	36.74	38.55	24.60	35.90	28.95	32.95
Pounds per bushel	59.81	64	56	61.62	59	60.08
Michigan Amber	32	33.70	26.02	29.08	24.85	29.13
Pounds per bushel	60.66	63.75	57	61.87	61.50	60.95
Velvet Chaff	31.60	35.37	24.88	31.63	24.92	29.68
Pounds per bushel	61.91	63.25	59.4	63	62	61.71
Average yield	34.16	36.12	25.31	34.30	27.18	
Average weight	60.17	63.10	56.98	61.65	59.87	

*Owing to drouth and insects the experiment in Madison County was abandoned in 1895.

X. Coöperative Test of Varieties of Corn.

This experiment, like the previous one, has been conducted the last two years. The purpose of the experiment is to ascertain the adaptation of a few varieties of corn to different parts of the State, and also to note the effect of climate and soil on the height of stalk, yield, etc. The results of the experiment for the two years are given in the accompanying table:

YIELD PER ACRE, HIGHT OF STALK, ETC.

VARIETY.	ELKHART COUNTY.			GRANT COUNTY.			BARTHOLOMEW CO.			POSEY COUNTY.			Average Yield, Bushels.
	Yield, Bu.	Hight, inches.		Yield, Bu.	Hight, inches.		Yield, Bu.	Hight, inches.		Yield, Bu.	Hight, inches.		
		Base of ear.	Tip of stalk.		Base of ear.	Tip of stalk.		Base of ear.	Tip of stalk.		Base of ear.	Tip of stalk.	
Orange Judd	68.01	45	99	34.90	38	48	......	......	......	......	......	......	51.45
DeKalb yellow	69.15	40	92	31.64	44	42	......	......	......	......	......	......	50.39
One-hundred-day yellow	66.87	40	90	39.58	46	46	......	......	......	......	......	......	53.18
Hartman's white	67.16	45	97	45.71	54	56	......	......	......	......	......	......	56.43
Early yellow	64.85	39	88	37.29	44	44	......	......	......	......	......	......	51.07
Riley's favorite	69.02	45	100	39.90	42	44	......	......	......	......	......	......	54.46
Wayne county white	......	......	......	......	......	......	72.14	57	122	80.26	55	119	76.19
Smith's improved	......	......	......	......	......	......	63.01	50	119	64.12	50	105	63.56
Success white	......	......	......	......	......	......	51.11	64	123	92.17	58	123	71.64
Fleming's yellow	......	......	......	......	......	......	67.63	46	121	78.51	44	97	73.07
Boone county white	......	......	......	......	......	......	60.80	57	125	80.54	46	106	70.67
White prolific	......	......	......	......	......	......	66.04	56	126	93.61	58	130	79.82

Other experiments are in progress and will be reported as early as conclusions of practical value can be reached.

Respectfully submitted,

W. C. LATTA,

Agriculturist.

TREASURER'S REPORT EXPERIMENT STATION.

As Treasurer of Purdue University, I hereby submit my report of all monies received during the year ending June 30, 1895:

From U. S. Government	$15,000 00
From Farm receipts	1,073 77
	$16,073 77

JAMES M. FOWLER,
Treasurer Purdue University.

FINANCIAL STATEMENT.

The Agricultural Experiment Station of Indiana in account with the United States, year ending June 30, 1895.

DEBIT.

Appropriation for 1895		$15,000 00

CREDIT.

Salaries	$8,367 23	
Labor	3,322 75	
Publications	1,151 13	
Supplies	430 77	
Heat and light	241 20	
Live stock	233 30	
Postage and stationery	128 60	
Freight and express	109 05	
Feeding stuffs	139 42	
Library	165 33	
Tools, implements and machinery	187 54	
Furniture and fixtures	150 97	
Scientific apparatus	97 57	
Traveling expenses	89 10	
Contingent expenses	55 39	
Building and repairs	50 41	
Fertilizers	41 55	
Chemical supplies	38 69	
		$15,000 00

I hereby certify that the above is a correct statement of expenditures in Station fund for year ending June 30, 1895.

E. A. ELLSWORTH,
Secretary of Board.

IMPROVEMENT FUND EXPERIMENT FARM FOR YEAR ENDING JUNE 30, 1895.

DEBIT.

Balance unexpended June 30, 1894		$376 54
Receipts from farm for 1895		1,073 77

CREDIT.

Labor	$196 02	
Postage and stationery	9 05	
Freight and express	12 82	
Supplies	41 09	
Contingent expenses	39 10	
Live stock	4 00	
Balance	1,148 23	
	$1,450 31	$1,450 31

I hereby certify that the above is a correct statement of expenditures from improvement fund for year ending June 30, 1895.

E. A. ELLSWORTH,
Secretary of Board.

I7ea

PURDUE UNIVERSITY.

NINTH ANNUAL REPORT

OF THE

AGRICULTURAL EXPERIMENT STATION

LAFAYETTE, INDIANA.

1896.

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.
1897.

PURDUE UNIVERSITY.

NINTH ANNUAL REPORT

OF THE

AGRICULTURAL EXPERIMENT STATION

LAFAYETTE, INDIANA.

1896.

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.
1897.

THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
INDIANAPOLIS, January 28, 1897.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF AUDITOR OF STATE,
INDIANAPOLIS, January 28, 1897.

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

A. C. DAILY,
Auditor of State.

January 28, 1897.

Returned by the Auditor of State with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

CHAS. E. WILSON,
Private Secretary.

Filed in the office of the Secretary of State of the State of Indiana, January 28, 1897.

WILLIAM D. OWEN,
Secretary of State.

Received the within report and delivered to the printer this 28th day of January, 1897.

THOS. J. CARTER,
Clerk Printing Bureau.

EXPERIMENT STATION BUILDING.

To the Governor:

I herewith transmit the annual report of the Purdue University Agricultural Experiment Station, due February 1, 1897.

Very respectfully,

C. B. STUART,
President Board of Trustees.

January 26, 1896.

To the President of the Board of Trustees:

I herewith present the annual report of the Agricultural Experiment Station of Indiana, due on or before the 1st of February, 1897, the same being required by section 3 of an act of Congress, entitled, "An act to establish agricultural experiment stations in connection with the colleges established in the several States, under provisions of an act approved July 2, 1862, and of the acts supplemental thereto."

This report consists of a report of the Director of the Station, and the financial report of the Secretary to the Board of Trustees.

Respectfully submitted,

J. H. SMART,
President.

PURDUE UNIVERSITY, LAFAYETTE, IND., January 26, 1896.

BOARD OF CONTROL.

Charles B. Stuart, President.....LaFayette, Tippecanoe County.
William A. Banks........................LaPorte, LaPorte County.
Sylvester Johnson........................Irvington, Marion County.
David E. Beem..................................Spencer, Owen County.
Job H. Van Natta.................LaFayette, Tippecanoe County.
Benjamin Harrison...................Indianapolis, Marion County.
William H. O'Brien............Lawrenceburg, Dearborn County.
James M. Barrett.........................Fort Wayne, Allen County.
John Martin............................Brookville, Franklin County.

JAMES H. SMART, LL. D.,
President of the University.

EDWARD A. ELLSWORTH,
Secretary.

JAMES M. FOWLER,
Treasurer.

STATION STAFF.

Charles S. Plumb, B. S. .... Director.
William C. Latta, M. S. .... Agriculturist.
James Troop, M. S. .... Horticulturist.
Henry A. Huston, A. M., A. C. .... Chemist.
Joseph C. Arthur, D. Sc .... Botanist.
Arvill W. Bitting, D. V. M. .... Veterinarian.
Jesse M. Barrett, B. S., A. C. .... Assistant Chemist.
William Stuart, M. S. .... Assistant Botanist.
William B. Anderson, B. S. .... Assistant Agriculturist.

NINTH ANNUAL REPORT

OF THE

Purdue University Agricultural Experiment Station

REPORT OF THE DIRECTOR.

To President James H. Smart:

SIR—I herewith take pleasure in transmitting to you the Ninth Annual Report of the Purdue University Agricultural Experiment Station for the year 1896.

The *experimental work* of the year has been in the main along lines already well established. While this Station is supposed to have been established in 1887, with the acceptance by the State of the provisions of the General Government establishing the Stations through the Hatch Act, experimental work really began with the earliest years of the University Agricultural Department. In September, 1878, ten acres were set apart for experiments with field crops, and this work was soon after established by Prof. C. L. Ingersoll, who in 1879 assumed the Chair of Agriculture in the University. In 1876 the Second Annual Report of the University contained reports of experiments by Dr. Wiley, Professor of Chemistry, and the annual reports were thereafter used as a medium for publishing agricultural investigations, until 1883. In 1884, three years before the present Station was organized, the publication of the bulletin was begun, which has continued without interruption up to the present time.

I have made the above statement to show that experimental work in behalf of agriculture at Purdue has been conducted for a much longer period of time than many might be aware of. In connection with the Agriculturist, certain field experiments have been continued now for fifteen successive years, a record that probably has not been made by any other station in America.

The growing season of 1896 was one of unusual moisture in this locality, so that plants in general grew and yielded entirely satisfactory crops. The rainfall for July and August was much greater than the normal, but this was not to the detriment of the crops on the station grounds.

Little new work has been planned by the Agriculturist, the old lines of work being continued much as before. A few field tests, however, were attempted. The greatly increased attention given to Kafir corn as a drouth-resisting plant, led to some comparisons of this with Indian corn at this Station, but the wet season seemed to delay the ripening so that a satisfactory comparison could not be made. In fact the Kafir corn did not mature satisfactorily. A series of grass and forage crop plats was established early in the spring, and some attention will be devoted to these plants in the future.

In the *Botanical Department* new experiments of more than passing interest have been begun. What may perhaps be considered the most important of these is an experiment on roses grown in pots, with a view of ascertaining the effectiveness of different forms of phosphates upon the plants. This work involved the use of two different varieties of 122 rose plants grown in pots, in several distinct types of soil, subject to certain conditions of control of soil moisture and fertility. The pots were kept on trucks and the vegetation house was used for shelter as occasion demanded. But very little work has been done along this line in this country, and as it is a field of much interest to florists and flower growers the work will be continued during 1897, the 1896 plants being in rest for this purpose.

Important experiments with lettuce have been in progress during the growing season in the greenhouse, involving questions of soil moisture and fertility, and this work is still in continuation, and promises results of interest and importance. One of the most important investigations of the year in the

department has been the examination into the merits of formalin as a preventive of potato scab. This non-poisonous substance has, after one season's trial, given results that furnish a basis for the belief that it will do the work as well, if not better, than corrosive sublimate. As the latter is a deadly poison, if formalin can be used with economy and success in place of it, we may regard this discovery as an important one in the work of the department. The results of last season's work with this substance are now in manuscript in the writer's hands and ready for publication.

In the *Chemical Department*, in addition to the routine work, important investigations concerning soils and soil fertility have been begun and continued.

In the southern part of the State much interest is taken in soil fertility by the farmers, as in many localities in that region the benefits of manures in the soil are felt in no slight degree. Realizing that some field experimental work with plant food could be undertaken to advantage by the Station, arrangements were made to this effect in Orange and Monroe counties. This work involved a study of the fertilization of types of clay soils, on which wheat and corn should be grown, and a further study of the soils themselves from both chemical and mechanical standpoint. This work was placed in charge of the Chemist, who selected the land for the experiment, and who has on several occasions superintended the necessary planting, fertilizing and harvesting. This line of experimentation meets with the warm approval of many people interested in improving our soil fertility, and we trust that it may give returns that will largely benefit all concerned.

Another important line of soil study is associated with our experimental plats, as well as the soil in southern Indiana above referred to. With the establishment of the present experimental plats, samples of soils were taken and set aside for further examination and study. Since then other samples have been taken, including 1896, and during this year analytical work has been in progress, with a view of ascertaining the influence of the cultural and other conditions on the soil fertility and cropping during the past ten years. This work is still in progress, but results of interest are apparent.

The work with sugar beets has been continued, only in a limited way, but in view of the great importance of this subject the Station will continue its investigations to some extent in the future, that its services may be of use should the production of sugar from beets be undertaken in the State.

In the *Horticultural Department* but little has been attempted along new lines of research. Most of the work consists of a study of the varieties of fruits in the orchard and garden, with a limited amount of other work, as, for example, close root pruning of trees, use of insecticides and fungicides, a study of bud variation, etc.

The necessity of a greenhouse for this department becomes more and more manifest each year. The writer knows of no institution similar to this, where the horticultural interests are generally recognized, in which the horticulturist is entirely unprovided with an opportunity for winter work. Until such facilities are provided him, this department may be considered as working at a far greater disadvantage than is desirable.

The work of the *Veterinary Department* has been conducted during the year in directions of vital importance to the stockmen of the State. The ravages of hog cholera, which have been excessive for the past two years, amounting to over three million dollars in 1895, have received special attention. Herds of diseased swine have been examined, experimental work has been attempted, both as preventive and curative of the disease, and an extended study of the prevalence of the malady in the State has been made from 1882 to 1896. The work of the station has attracted much attention in this direction, and the edition of a bulletin on hog cholera and swine plague, prepared by the Veterinarian, was soon exhausted after its appearance, owing to the unusual demand. A study of this disease will be continued during 1897, as a most important one of the department.

The subject of tuberculosis has also received much attention from the Veterinarian during the year, the tuberculin test having been tried on over 300 head of cattle. In view of the fact that tuberculosis in cattle and human consumption are identical, it is highly probable that in the future more and more interest will be taken by stockmen in eradicating this disease, which is more or less prevalent, from their herds. A bulletin on the subject, prepared by the Veterinarian, was published in

December, which gave a comprehensive survey of this disease under the title of "Bovine Tuberculosis in Indiana."

A comparatively new and interesting field of research, that of the study of bacteria in the stable, as bearing on hygiene, was taken up by Dr. Bitting and Mr. Charles Davis, a senior agricultural student, and interesting results were secured. Material is available for publication on this subject.

No experimental work has been conducted in the dairy during the year, the conditions not being satisfactory for such work. During five months of the year, however, the dairy is used for instructional purposes.

Several feeding experiments with calves, sheep and swine have been carried on during the year for longer or shorter intervals. In the winter a comparison of the feeding value of shredded corn fodder and clover hay was made on a bunch of twelve lamb wethers. In the summer another experiment was conducted, not with the most satisfactory results, comparing rape and blue grass as pasture, both for sheep and for lambs. Dogs, unfortunately, got among these sheep and injured enough of them to abruptly terminate the experiment.

Calf feeding experiments have been continued, as during the past few years, bearing on the value of different foods in producing flesh. A feeding experiment with young growing pigs was conducted to compare the feeding value of hominy feed, shorts and skim milk with cornmeal, shorts and skim milk. Four female pigs were used in this experiment, which extended from the middle of October till December. Another experiment with pigs, related to the influence of a grain ration of shorts and cornmeal on a suckling sow and pigs, compared with a ration of shorts, cornmeal and skim milk.

During the year some experimental feeding of chickens was conducted, one lot of fowls being fed to study the influence of carbonaceous and nitrogenous foods on flesh production; and the other a study of the feeding value of skim milk with young growing chickens.

In addition to the investigations heretofore mentioned, as conducted in the several departments, other lines of research have been in progress which have been referred to in previous reports, that do not need mention at this time. Fuller information concerning the work of the Station is given in the reports of the different departments, in this volume.

The *Station Staff* has remained unchanged in every respect during the past year, excepting in the appointment of Mr. W. B. Anderson, B. S., a graduate of the University School of Agriculture, to the position of Assistant Agriculturist, in June.

Improvements of the most important character have been made in the Station building during the year. The chemical laboratory has been removed from the suite of rooms occupied upstairs on the east side of the building, and provided with far better accommodations on the first floor immediately below, and in the old L, before this used as a store room, but which was remodeled and fitted into a general laboratory, small store room and polariscope room. This change made it necessary to provide new accommodations for the Veterinary Department, which were found in the old quarters of the Chemical Department above, which were repainted and otherwise improved and repaired. The two rooms occupied by the Horticulturist were vacated by him for rooms on the second floor over the Director's offices. Of these two vacated rooms one was added to the Chemical Department and the other to the Botanical Department, to be used for a class room. The hall extending from the center of the building to the east has been closed up, and is now used as a store room and closet for the Botanical Department. These changes that have been made, have resulted in providing the Chemical and Veterinary departments with unusually complete accommodations for laboratory work, and especially the former. More detailed descriptions of the laboratories and equipments of the Chemist, Veterinarian and Botanist are to be found in their reports further on. A reference to the floor plans, also included in this report, will greatly assist the reader in comprehending the scope of the Station laboratories.

Additional to the above improvements, which, by the way, it is very appropriate to state, were made at the expense of the University, and not the Station, may be mentioned the painting and general improvement of the library room, which has greatly added to its appearance.

On the farm but little has been accomplished in new improvements. The entire east side of the Station grounds was refenced in the spring with post and smooth wire, some eighty rods in all. About forty rods of neat post and board fencing was also

built, facing State street and just west of the Station building and north of the experimental plats. These improvements were very necessary as a proper protection of our experimental plats, and have added greatly to the appearance of the establishment. Some more fencing on the north and west end of the farm needs attention, as well as on the east and west side of the pasture, but, as a rule, nearly all of the fencing surrounding the Station property is in excellent shape.

Important improvements are, however, most desirable at the farm. The buildings need repainting very much indeed. The tool building should be enlarged to provide suitable accommodations for our excellent and constantly growing collection of implements. We have no pig house worthy of the name, although it is very desirable that the Station should give a proper amount of attention to swine feeding, an industry of great magnitude in Indiana. To do this work properly, suitable housing accommodations should be available on the farm for our swine. The same may also be said relative to a sheep building, the present one being small and not creditable to the State. An appropriation of $1,500 for swine and sheep buildings could be used to great profit. The old silo in the cattle barn is in such poor condition that a new one should be built in time for filling it with the crop of 1897. The old one will not do, and a new one is a necessity from the standpoint of economy.

The *publications* of the Station for this year have been as follows:

PAMPHLET BULLETINS.

No. 58, Vol. VII, February, 1896, pp. 10. Hog cholera and swine plague in Indiana. By A. W. Bitting.

No. 59, Vol. VII, March, 1896, pp. 11–40, plates VIII. Bacteriosis of carnations. By J. C. Arthur and H. L. Bolley.

No. 60, Vol. VII, April, 1896, pp 41-54, plates IX–XIV, figures 25–31. The American persimmon. By James Troop and O. M. Hadley. Composition of the persimmon. By H. A. Huston and J. M. Barrett.

No. 61, Vol. VII, August, 1896, pp. 55–70. Field experiments with wheat. By W. C. Latta and W. B. Anderson.

No. 62, Vol. VII, October, 1896, pp 71–96, figures 32–42. The udder of the cow. By C. S. Plumb.

No. 63, Vol. VII, December, 1896, pp. 97–116, plates XV–XVI. Bovine tuberculosis in Indiana. By A. W. Bitting.

In addition to the above there was published the

Eighth Annual Report of the Agricultural Experiment Station, 1895, pp. 44,

And the following twenty-four

NEWSPAPER BULLETINS.

No. 18. January 4, 1896. On the winter protection of live stock. By C. S. Plumb, Director.

No. 19. January 21, 1896. Use of commercial fertilizers in Indiana. By H. A. Huston, Chemist.

No. 20. February 7, 1896. Kafir corn in Indiana. By W. C. Latta, Agriculturist.

No. 21. February 28, 1896. Alfalfa without irrigation. By W. C. Latta, Agriculturist.

No. 22. March 25, 1896. Oats and field peas for green fodder. By C. S Plumb, Director.

No. 23. April 8, 1896. Spraying with insecticides and fungicides. By James Troop, Horticulturist.

No. 24. April 15, 1896. Prevention of potato scab. By J. C. Arthur, Botanist.

No. 25. April 27, 1896. Artichokes as stock food. By C. S. Plumb, Director.

No. 26. May 12, 1896. Two important currant insects. By James Troop, Horticulturist.

No. 27. May 15, 1896. Preventing chinch bug ravages. By James Troop, Horticulturist.

No. 28. June 5, 1896. Destroying the Russian thistle. By J. C. Arthur, Botanist.

No. 29. June 25, 1896. The use of the hand or baby separator on the farm. By C. S. Plumb, Director.

No. 30. July 8, 1896. Killing the horn fly. By C. S. Plumb, Director.

No. 31. July 16, 1896. Crimson clover in Indiana. By W. C. Latta, Agriculturist.

No. 32. August 15, 1896. Stomach worms in sheep. By A. W. Bitting, Veterinarian.

No. 33. August 28, 1896. Winter oats in Indiana. By W. C. Latta, Agriculturist.

No. 34. September 19, 1896. Notes from the Experiment Station. By C. S. Plumb, Director.

No. 35. September 30, 1896. Shredding corn fodder. By C. S. Plumb, Director.

No. 36. October 10, 1896. Hog cholera. Suggestions to swine growers. By A. W. Bitting, Veterinarian.

No. 37. October 28, 1896. Keeping fall and winter apples. By James Troop, Horticulturist.

No. 38. November 20, 1896. The setting of milk. By C. S. Plumb, Director.

No. 39. December 5, 1896. Feeding hogs for quality of meat. By C. S Plumb, Director.

No. 40. December 19, 1896. The sugar beet question in Indiana. By H. A. Huston, Chemist.

No. 41. December 30, 1896. Hints on window gardening. By William Stuart, Assistant Botanist.

There was also published a poster bulletin on the Russian thistle that was distributed to those counties in the State in which this pest has been discovered.

Mailing List. The above periodicals are very widely scattered. The pamphlet bulletin is distributed as a rule to the entire mailing list, which now numbers 13,297 names. This list, however, is growing so rapidly that 14,500 copies of bulletin 63 were printed in order to provide a surplus for future use. The newspaper bulletins are one page sheets of about 450 words, and editions of 700 of these are printed, of which some 600 go to Indiana periodicals, and about 50 outside the State.

The following table shows the size of the mailing list at the beginning of each year since 1893:

STATION MAILING LIST.

Number of Names on List of	Jan. 18, 1893.	Jan. 4, 1894.	Jan. 10, 1895.	Jan. 1, 1896.	Jan. 1, 1897.
People in Indiana	5,741	7,131	8,666	9,143	10,590
Indiana periodicals	635	668	653	625	660
People in other States	1,158	1,316	1,606	1,788	1,872
Periodicals in other States	83	91	86	92	76
Foreigners	26	51	61	77	91
Foreign periodicals	7	7	7	6	8
Total	7,650	9,264	11,079	11,731	13,297

During this year, a beginning has been made in revising this list, and notices will, from time to time, be attached to the generally circulated bulletins, requesting an acknowledgment of its receipt, with an expression if wished in future. From these acknowledgments a new list will be made, which will eventually be the only one in service at the Station.

The *income* of the Station, as may be seen by the Treasurer's report, consists of $15,000 per year from the United States Government, and the proceeds of the farm's sales, which range from $1,000 to $2,000. This sum is not large enough to meet the serious demands of the Station, which has steadily grown during the past ten years, while its income has really remained at a standstill. The improvements referred to elsewhere as necessary are important ones, and can not be accomplished from our present income. Assistance, in my opinion, should be rendered by the State. Even if the State would appropriate only sufficient funds for printing our various publications, this would place over $1,000 more a year as available for other purposes. The most important things in the life of the Station are its investigations, and the next thing of importance is the disseminations of the information obtained through them. If the United States Government provides the money for doing the work, the State, at least, can afford to pay for the publication of the results of it.

The following figures show the revenue for some of the agricultural experiment stations of the country for the year 1893, the most recent ones available to the writer:

New York State	$68,500
California	33,810
Wisconsin	29,980
Massachusetts (Hatch and State)	29,104
Ohio	28,936
Louisiana	26,600
New Jersey (State and College)	26,000
Alabama	24,878
Pennsylvania	24,874
North Carolina	23,400
Georgia	22,000
Connecticut (State)	21,671
Indiana	16,532

All of these stations received aid from the State excepting Indiana, and through this State assistance they have been able to materially add to the value of their services to the State. I

trust that the State of Indiana will see fit in the near future to show its appreciation of the work of this Experiment Station by making such an increase to our income as will enable us to add to our laboratory facilities and accomplish a greater amount of work than is at present possible.

I herewith submit the annual reports of the several departments of the Station as a part of this, the Annual Report of the Experiment Station for 1896. I also add as an appendix a list of gifts presented the Station during the year, including periodicals.

Respectfully submitted,

C. S. PLUMB,
Director.

REPORT OF THE AGRICULTURAL DEPARTMENT.

To C. S. Plumb, Director:

SIR—The work of the department for the year 1896 has been, in the main, a continuation of lines of investigation previously planned.

A new experiment was undertaken last spring to ascertain the relative merits of Kafir and common corn as field crops.

Some new experiments with wheat have been planned, and a number of grasses were sown in the spring of 1896, both singly and in mixtures. Some twenty-five or more packages of grass and forage plant seeds were received last spring from the United States Department of Agriculture at Washington, D. C., and sown in small sample beds.

The growing season of 1896 was very favorable at the Station for all spring crops and for pastures and meadows. The season was also fairly favorable to wheat. The yields of oats at the Station were better in 1896 than in any previous year since the establishment of the Station.

I. EXPERIMENTS WITH VARIETIES.

1. Wheat. Number of varieties grown in 1896, eight; time under trial, one to 13 years; average yields, range from 17 to 29 bushels; yields in 1896, range from 13 to 30 bushels; more promising varieties, Michigan Amber, Willett's, Velvet chaff.

2. Oats. Number of varieties grown in 1896, 27; time under trial, one to eight years; average yields, range from 34 to 62 bushels; yields in 1896, range from 51 to 84 bushels; more promising varieties, Black, American banner, White Russian, Black prolific

3. *Grasses and Clovers* sown in the spring of 1896 were *Bromus inermis* (Awnless brome grass); *Bromus pratensis* (meadow brome grass); *Festuca elatior* (taller fescue); *Avena elatior* (tall oat grass); timothy, red top, orchard grass, alsike, common red and mammoth clovers.

The clovers all started well and made a good stand; the timothy made a fair stand. The red top did fairly well and the orchard grass very well. The other grasses did not succeed well, although the conditions appeared to be very favorable. Doubtless the seeds were lacking in vitality. A mixture of grasses consisting of orchard grass, tall oat grass, meadow fescue and common clover was sown on one plat. At the end of the season, the orchard grass and common clover quite fully occupied the ground. The other grasses in the mixture made very little showing.

On another plat a mixture of timothy, red top, taller fescue and mammoth clover was sown. The taller fescue failed to do much. The timothy, red top and mammoth clover all did well. These grass plats were clipped with the mower several times to check the growth of weeds. Of the grasses and forage plants sown on the sample beds, the following failed to grow, namely: *Iris pabularis*, *Eragrostis neo Mexicana*, *Tripolium Alexandrinum*, *Arundinaria macrosperma*. Alfalfa and alsike, red top and mammoth clovers, all made a good growth.

Festuca elatior made a thick growth three or four inches high, but formed no heads. It would prove to be a good pasture grass where it grows well. *Bromus pratensis* made a dense growth, the leaves being eight inches long; no heads were formed. This would doubtless prove an excellent pasture grass. *Bromus inermis* also made a good growth, though hardly equal to *pratensis* in stand. About one-third of the seed failed to grow. *Festuca pratensis* made a soft growth of plants five to six inches high, completely covering the ground. It will doubtless prove a valuable pasture grass. *Dactylis glomerata* (orchard grass) made a thick, heavy growth eight or nine inches high, but formed no seed stalks. It is one of the best pasture grasses. *Phleum pratense* (timothy) made a growth eight to twelve inches high and formed many small heads; the stand was very good. *Agrostis vulgaris* (red top) made a thick growth about five inches high, but formed no heads. *Avena elatior* (tall oat grass) made a dense growth about ten inches high; would doubtless prove a good pasture grass. *Panicum Texanum* (Texas panic grass) made a growth four feet high. It is a very coarse grass, developing woody stems when the plant ripens. Horses, cattle and sheep ate it readily when samples of it were used before maturing. *Lespedeza striata*,

(bush clover), made a growth about four inches high, forming a thick mat over the ground; it does not appear to possess value for this section. *Eragrostis Abyssinica* made a good stand and a rapid growth. It would probably make an excellent pasture grass. Horses, cattle and sheep ate it readily when cured as hay. *Medicago maculata* (spotted medick) made a good stand, but the growth was only two or three inches high. It appears to have little economical value for this section. *Desmodium tortuosum* (tick trefoil) made a coarse growth with rounded leaves and woody stems. No stock would eat it, either green or as hay. *Saccaline* (knot weed) made a poor stand. The growth was from twelve to fourteen inches high. Stock cared very little for it. *Cystisus proliferous alba* made a poor stand. The growth was only about four inches high. It has practically very little value. Persian clover made a growth about six inches high. The stand, however, was poor. It appears to have little value either as hay or for pasture.

4. Lathyrus sylvestris. This is a species of legume, but is an exceedingly slow grower at this Station. It was sown in the spring of 1894. The crop the first year was not over four or five inches high, the second year about six or eight inches. In 1896 the growth was perhaps 12 or 15 inches high. Stock refused to eat it, unless put on short allowance, in either the green or cured form. It has no value whatever as a crop in rotation. It might prove of value on light sandy soils, in case it could be allowed to grow for a number of years. It strikes root deep in the soil and would, in six or eight years, doubtless effect a considerable improvement in light, worn out soils.

II. Thick and Thin Sowing of Wheat.

Quantity of seed sown, two to eight pecks per acre; time under trial, 12 years; range of average yields, 23 to 30 bushels; range of yields in 1896, nine to 31 bushels; highest average yield produced from seven pecks to the acre; lowest average yield from two pecks per acre.

Velvet chaff wheat has been used chiefly in this experiment. In 1896 both Velvet chaff and Rudy wheats were used.

III. Early and Late Sowing of Wheat.

Range of dates previous to the fall of 1893, September 18 to October 18; range of dates since the fall of 1893, September 13 to October 9; time under trial, eight years; range of average yields, 21 to 34 bushels; range of yields in 1896, seven to 27 bushels; highest average yield from sowing, September 18 to 20.

IV. Deep and Shallow Culture of Corn.

Time under trial, eight years; range in depth of culture, 1 to 4 inches; average yields per acre, as follows:

From cultivation, 1 inch deep	44 bushels.
From cultivation, 2 inches deep	43 bushels.
From cultivation, 3 inches deep	41 bushels.
From cultivation, 4 inches deep (last three years only)	29 bushels.

Yields in 1896—

Culture, 1 inch deep	52 bushels.
Culture, 2 inches deep	51 bushels.
Culture, 3 inches deep	53 bushels.
Culture, 4 inches deep	47 bushels.

The low average yields in the first total are due to drouths in 1893, 1894 and 1895.

V. Experiments with Corn Cultivators.

The following named implements have been under trial in this experiment:

1. The Albion spring tooth wheel cultivator, with six teeth in each gang.

2. The Tower's surface cultivator, whose reversible, flat blades shave the soil, but stir it only to a very slight depth.

3. The Hoosier cultivator, which has flat blades, whose action is much the same as that of Tower's cultivator.

4. The Corn plow, consisting of two shovels in each gang. Bull tongues have been used instead of the inside shovel for the first and second cultivation, as a rule.

5. The Planet Junior one-horse cultivator, with leveling attachment.

6. Breed's weeder, a shallow working tool with numerous curved spring teeth. This implement has been used for the first two cultivations and then succeeded by the one-horse harrow.

The results obtained by these cultivators are shown in the following table:

NAME OF CULTIVATOR.	TIME UNDER TRIAL.	YIELD PER ACRE.
Albion spring tooth	8 years	57 bushels.
The Corn plow	8 years	55 bushels.
The Hoosier	7 years	55 bushels.
Tower's	4 years	56 bushels.
Planet Junior	5 years	53 bushels.
Breed's weeder and harrow	3 years	53 bushels.

The above showing is unfair to the implements which have been under trial a short time, owing to the drouths of 1893, 1894 and 1895.

The yields obtained in 1896 from these implements are as follows:

Albion spring-tooth cultivator	82.48 bushels.
Corn plow	85.50 bushels.
The Hoosier cultivator	88.40 bushels.
Tower's cultivator	87.86 bushels.
Planet, Jr., cultivator	82.78 bushels.
Breed's weeder and harrow	82.14 bushels.

VI. EFFECTS OF PREVIOUS MANURING ON YIELD OF CORN.

The ground devoted to this experiment has grown corn continuously since 1880. In 1883 and 1884, fresh horse manure was applied to alternate plats, amounting for the two years to about 50 tons per acre. No manure has been used in this series of plats before or since the two years named. The manured plats show an average increased yield per acre of more than 10 bushels. The *aggregate increase* from the manure in 13 crops has been 132 bushels to the acre. The increase in 1896 was three bushels to the acre, showing that the manure has not yet been exhausted.

The crop of 1887 was an almost total failure, owing to the severe drouth that year, and it is not therefore included in the figures given above.

VII. The Effect of Rotative Cropping and Continuous Grain Growing on Yield.

Corn, wheat and oats have been grown *continuously or in alternation*, one with another, on one series of plats for 15 years. The same crops have been grown in *rotation with grass and clover* on an adjacent series of plats for a like period. The grain, hay, stalks and straw have been regularly removed from both series of plats and no manure or fertilizer has been used on either series since the experiment began.

The average yields per acre on the two series are as follows:

Name of Crop.	All-Grain Series.	Rotative Series.	Gain From Rotation.
Corn	27 bushels	33 bushels	6 bushels.
Oats	27 bushels	34 bushels	7 bushels.
Wheat	14 bushels	20 bushels	6 bushels.

The gains from rotation expressed in per cents. are, corn, 22 per cent.; oats, 26 per cent.; wheat, 44 per cent. Both series were plowed and put into corn in the spring of 1896. The following yields per acre were obtained:

All-grain series............................48.42 bushels.
Rotative series............................54.08 bushels.
Gain from rotation........................ 5.66 bushels.
Per cent. gain.............................11.7 bushels.

Two important results were gained from this experiment:

1. Larger crops can be secured by a judicious system of cropping.

2. The fertility of the soil is better conserved by such a system of cropping.

VIII. Heavy and Light Applications of Manure and Fertilizer.

This experiment was begun in 1889, and has been carried on continuously since. The plan of the experiment includes a variety of crops to be grown in shorter or longer rotations, and also the continuous growing of wheat and corn on the several series of plats. Certain plats in each of the several series received heavy and light applications of fertilizers or manure.

Frequently recurring and severe droughts have thus far

greatly interfered with this series of experiments. In some cases the drouth has been so intense as to prevent the manure or fertilizer from having any beneficial effect upon the yield.

The *lighter* applications of manure have generally proved profitable. *Heavy* manuring has proved very unprofitable (in a few instances), or less profitable than *light* manuring. The lighter applications of fertilizers have in some instances proved profitable, while the heavy applications, though sometimes producing a marked effect on yield, have generally proved unprofitable.

In explanation of the above it should be stated that the soil of the station farm is still sufficiently fertile to produce, in favorable seasons, about twenty bushels of wheat or forty bushels of corn without fertilization.

IX. Comparative Yield of Common and Kafir Corn.

The experiment was undertaken in the spring of 1896 to determine the relative yield of stalk and grain of common corn as compared with the red and white varieties of Kafir corn. The plats which were devoted to this experiment lay side by side, and were of the same form and size, about one-tenth acre each. The accompanying table gives the yield in pounds of stalks and in bushels of grain fifty-six pounds each.

The yields of the two varieties of Kafir corn were determined from sample heads, and are therefore only approximately accurate.

YIELDS PER ACRE OF CORN AND KAFIR CORN.

Variety.	Stalks.	Grain.	Total Crop.
Purdue yellow corn	5,972 pounds..	79.60 bushels...	11,544 pounds.
Red Kafir corn	10,706 pounds..	18.87 bushels...	11,763 pounds.
White Kafir corn	11,205 pounds..	25.51 bushels...	12,634 pounds.

It appears that the white Kafir corn gave a considerably heavier yield of total crop, but that the yield of the grain of both varieties was much less than that of corn. This is in part due to the fact that a rather early frost prevented the full maturing of the Kafir corn.

X. Comparative Test of Varieties of Corn.

This experiment has been conducted three years. Its purpose is to determine the adaptation of a few leading varieties of corn to the different sections of the State and also to note the effect of climate and soil on the height of stalk, yield, etc. The following table shows the average results obtained, for the three years of the test, in the several counties in which the experiment was tried.

Table Giving Results of Co-operative Test of Varieties of Corn.

VARIETY.	Elkhart County.				Grant County.				Bartholomew County.				Posey County.				Average Yield, Bushels.
	No. Years Grown.	Bushels Per Acre.	Height, Inches. Base of Ear.	Height, Inches. Tip of Stalk.	No. Years Grown.	Bushels Per Acre.	Height, Inches. Base of Ear.	Height, Inches. Tip of Stalk.	No. Years Grown.	Bushels Per Acre.	Height, Inches. Base of Ear.	Height, Inches. Tip of Stalk.	No. Years Grown.	Bushels Per Acre.	Height, Inches. Base of Ear.	Height, Inches. Tip of Stalk.	
Orange Judd	*2	68.01	45	99	*2	34.90	38	86	.....	.....	.....	.....	.....	.....	.....	.....	51.45
Dekalb county yellow	3	66.92	38	91	*2	31.64	44	86	.....	.....	.....	.....	.....	.....	.....	.....	52.81
100 day yellow	*2	66.87	40	90	*2	39.58	46	92	.....	.....	.....	.....	.....	.....	.....	.....	53.18
Hartman's white	3	67.83	42	96	*2	45.71	54	110	.....	.....	.....	.....	.....	.....	.....	.....	58.98
Early yellow	3	64.05	38	86	*2	37.29	44	88	.....	.....	.....	.....	.....	.....	.....	.....	53.35
Riley's favorite	3	61.07	42	95	*2	39.90	42	86	†1	50.02	43	103	†1	50.34	39	93	51.91
Wayne county white	.....	.....	.....	.....	.....	.....	.....	.....	3	67.86	59	121	3	73.97	53	116	70.92
Smith's improved	.....	.....	.....	.....	.....	.....	.....	.....	*2	63.01	50	119	*2	64.12	50	105	63.56
Success white	.....	.....	.....	.....	.....	.....	.....	.....	3	61.23	62	120	3	78.80	52	117	70.02
Fleming's yellow	.....	.....	.....	.....	.....	.....	.....	.....	*2	67.63	46	121	*2	78.51	44	97	73.07
Boone county white	.....	.....	.....	.....	.....	.....	.....	.....	3	67.58	52	116	3	71.83	45	107	69.87
White prolific	.....	.....	.....	.....	.....	.....	.....	.....	3	70.83	56	125	3	81.12	48	113	75.99
Braxton's best	.....	.....	.....	.....	.....	.....	.....	.....	†1	64.03	53	115	.....	.....	.....	.....	64.03

* Grown in this county in 1894 and 1895.
† Grown in this county in 1896 only.

The table shows some interesting variations in yield as well as in height of ear and of entire stalk. The almost universal opinion of those who aided the station in making the test is to the effect that home grown varieties are more satisfactory than those from other localities.

Most of the field and tabular work, connected with the experiments of this department, was performed by the Assistant Agriculturist, Mr. W. B. Anderson, who discharged his duties in a very careful and efficient manner.

Respectfully submitted,

W. C. LATTA,
Agriculturist.

REPORT OF THE BOTANICAL DEPARTMENT.

To C. S. Plumb, Director:

SIR—The work in this department for the year 1896 has been, on the whole, as successful as heretofore, while some of the experiments have given results that are more than usually gratifying, both on account of their scientific bearing and their distinctly practical character. Much of the work has necessarily been upon subjects carried over from the preceding year, in accordance with the method of work explained in the last report, but some new and rather striking experiments have also been inaugurated that have led to excellent results. Of these the most prominent is the introduction of a new fungicide, known in the market as formalin, which proves to be a satisfactory substitute for corrosive sublimate in the prevention of potato scab, while possessing the great advantage of lacking poisonous properties. A perfectly safe as well as efficient preventive for this important crop disease has been greatly needed, and its discovery is likely to meet with an appreciative reception.

Besides the several lines of experimental work carried on during the year, and which will presently be mentioned more specifically, the interior of the greenhouse has been somewhat remodeled and the laboratories renovated. It is, therefore, thought to be an appropriate time to publish a brief description of the appliances and facilities for botanical work possessed by the Station. This seems the more desirable as many inquiries have shown a desire on the part of the public to have a better acquaintance with the institution in its several departments and classes of work. A brief account of the botanical department was given in the first annual report for 1888, but since then there have been additions and changes, and a steady growth that makes the department of to-day a far more efficient means of serving the public than the report

of eight years ago would indicate. Therefore, after giving an outline of the work for the last year, the present condition of the various appliances for carrying on the work will be described.

PRINCIPAL INVESTIGATIONS OF THE YEAR 1896.

It is impossible to give in this place more than a brief mention of the principal topics on which work has been done. There are many things which consume time, sometimes quite out of proportion to the intrinsic value of the information secured or results obtained, which call for no statement; such are the naming of specimens of plants, usually of weeds, advice upon all kinds of subjects, tests of seeds and alleged important new vegetables and flowers, trials of various plant foods and remedies for diseases, etc. These matters are usually answered by letter, sometimes when of sufficient general importance, through the press. Investigation is, however, considered the chief work of the department and the only part calling for specific mention.

Potatoes. The recent rapid prominence attained by formalin (also called formaldehyde) as a germicide, as well as for other practical purposes, naturally suggested its use in the prevention of plant diseases. The initial trial made in the greenhouse during the winter of 1895–6, looking toward its use in the prevention of potato scab, showed that tubers soaked for some hours in a solution of various strengths up to one part in 500 of water, were apparently unaffected in their growth by the treatment for either better or worse, so far as could be told from the subsequent appearance. Further test in the greenhouse indicated that while innocuous to the potato plant, it had germicidal action on the scab germ and largely or quite prevented scab in the crop of tubers raised from such treated seed. These preliminary trials were, indeed, of the most promising character.

Upon the opening of spring, field trials of the new fungicide were inaugurated, based upon the data obtained in the greenhouse trials. Not only were a series of experiments made at the Station, but the following persons consented to make independent tests of the new substance and to report to the Station. They were Mr. T. B. Terry, of Hudson, Ohio; Mr. Arthur

Hoadley, of Ockley, Ind.; Mr. William M. Reser, of Lafayette, Ind., and Mr. J. H. Skinner, of Romney, Ind. In all the trials of the season the results were of the most favorable sort, and appear to fully warrant the belief that in formalin the farmer has a valuable, cheap, non-po'sonous and satisfactory means of practically preventing pota o scab. The full report of this series of experiments has been written up and is now ready to appear in the form of a bulletin.

Roses. An experiment upon the effectiveness of different forms of phosphates upon roses was carried out in the vegetation house with excellent results. The work was especially under the charge of Mr. Wm. Stuart, the assistant botanist. The roses were selected to be as nearly as possible of uniform size and vigor. They were grown in zinc cans with good bottom drainage, one plant in a can, using two kinds of soil, a clay loam and a light garden loam. The test included 80 plants of *Kaiserin Augusta Victoria* and 42 of *Perle des Jardin.* The forms of phosphate used were raw bone meal, dissolved bone black, Pamunky phosphate and super phosphate, the first named giving the best results. The results were determined by the number and quality of the flowers, and length and number of the internodes. The full report, which is to be put in the form of a bulletin, will contain many interesting details that can not be mentioned here.

Corn. The study of the occurrence of corn smut and its prevention by spraying was continued during the season in much the same manner as reported for 1895, and with similar results. The unusual amount of rain in July interfered with the effectiveness of the spraying, and a heavy wind storm on July 19, which broke down much of the corn of the experimental plats, especially contributed toward making the test incomplete. The results so far attained have, however, seemed of sufficient value to warrant their public-tion in bulletin form, and are now being arranged for the purpose.

Carnations. The work which has been carried on since 1888 in the investigation of the bac'eriosis of carnations, a widespread and important disease of carnations, first detected and made known by this department, was embodied in a bulletin (No 59) of 25 pages and eight partly colored plates, issued in March. The bulletin, which gives practical directions for preventing the disease, has been warmly received by carnation

specialists and florists in general. The recommendations which have grown out of this work have been widely adopted and have brought about an entire change in the methods of watering and other details of treatment of the carnation under glass. A noteworthy feature of the bulletin is the use of two colored plates, the first so far issued by the Station, which illustrate a part of a diseased plant and three culture tubes of the germ, done in the most creditable style of chromolithography.

A peculiar abnormal condition of the flower buds of the carnation was examined in the early part of the year, and a paper on the same presented before the American Carnation Society at its annual meeting in New York. The petals of the flower become adherent in the bud, and are unable to separate at time for opening. The cause was not ascertained.

Lettuce. During the winter of 1895–6 two crops of lettuce were grown in the greenhouse for the purpose of studying the best ways of feeding, watering and handling this important winter crop. Excellent data were secured. The work is being repeated, however, with some modifications, during the present winter (1896–7), and when the records are arranged, the whole subject will be given to the public in the form of a bulletin.

Cinerarias. An examination into the merits of the cineraria as a flowering and decorative plant has been begun. Seeds were sown in June and at subsequent periods, and the first flowers appeared in December. Seeds have been obtained from most of the large dealers in this country and from some of the most prominent ones in Europe. About seventy packets of seeds are being tested, which include most of the best varieties known. It is yet too early to speak of the value of this work.

Weeds. Considerable attention is given to the occurrence and spread of weeds in the State. The intention is to gather data as it comes to hand, and to publish information from time to time. A newspaper bulletin giving directions for destroying the Russian thistle was issued in June.

Other topics. The trial of sub-irrigation for the garden was repeated this season with only indifferent results. Three newspaper bulletins were issued during the year. Beside the one on weeds, already mentioned, one was devoted to window gardening, written by the Assistant Botanist, and the third to the use of corrosive sublimate for the prevention of potato scab.

FLOOR PLAN OF BOTANICAL LABORATORY. Fig. 1.

EQUIPMENT OF THE DEPARTMENT.

The department has assigned to it and uses for its work two laboratory rooms with small store room and photographic dark room, a room for library and office, two greenhouse rooms, a vegetation house and from a half acre to two acres of ground as may be required in different years.

The Main Laboratory is 20 feet square, amply lighted and provided with more than the customary fittings for convenient use of water and gas. The available wall space is occupied with cases and desks, quite well supplied with the necessary kinds of glass and porcelain ware, reagents and stains, supplies for the microscope and other special aids to research.

A board shelf under the triple south window makes the best kind of work-table for using with a microscope, especially as the light is modified with white Holland shades. A Zeiss microscope, with a number of lenses made by Zeiss, Spencer and Bausch and Lomb, an Abbe camera lucida, a temperature chamber for the microscope and a microphotographic attachment, permit the carrying out of investigations of almost all kinds in which the microscope is a prime requisite. The laboratory also possesses a Verbeek and Peckholdt analytical balance, Springer torsion balance for fine weighings, and other balances for coarse work. An instantaneous water heater above the sink is one of the special conveniences of this room.

The Bacteriological Laboratory possesses a large hood to carry off vapors and gases, a vegetation chamber for cultivation of germs at constant temperature, steam and dry sterilizers and other appliances for working upon bacterial and other germ diseases

The Photographic Dark Room is fitted up with shelving and sink, and supplied with water and gas. The department possesses a camera provided with a 5x8 wide angle lens, made by Bausch & Lomb, and limited appliances for developing and printing photographs

The Office and Library is a room 12 by 20 feet, with wall cases for books, an herbarium case and an office desk. The last is used by the Botanist, while a desk for the Assistant Botanist is placed in the main laboratory.

The botanical library of the station contains about 200 bound volumes and a few pamphlets. About three-fourths of these are serial publications, and the remainder chiefly works on fungi, bacteria and plant diseases. They are distributed as follows:

Zeits. für wiss. Mikroskopie, 1884–88	5 vols.
Zeits. für Pflanzenkrankheiten, 1891–96	6 vols.
Hedwigia, 1852–1884	23 vols.
Berichte der Deutschen Bot. Gesellschaft, 1883–96	14 vols.
Botanische Zeitung, 1886, 1888, 1890–96	9 vols.
Botanisches Centralblatt, 1888–96	36 vols.
Just's Bot. Jahresbericht, 1873–81, 1886–88	12 vols.
Centr. für Bakt. und Parasit., 1887–96	20 vols.
Miscellaneous serial and other works	75 vols.
Total	200 vols.

The Station herbarium can scarcely be said to have been begun. The only mounted specimens are the two centuries of Halsted's "American Weeds," and five centuries of Linhart's "Fungi Hungarici." The number of unmounted specimens is insignificant. The demands upon the department for the identification of weeds and other flowering plants, and of parasitic fungi causing diseases, could not have been satisfactorily met had it not been for the availableness of the large collection of flowering plants and fungi owned by the Botanist.

The instruction of students in the regular University courses is part of the duty of the Botanist during the months of January, February, March. April and May, and the laboratory work arranged for such students is carried on in the rooms of the Station. The number of students—Junior, Senior and Post-graduate—has varied for the different years from four to fifteen, and the laboratory is occupied by them from six to ten hous each week. For this work the University has provided a fair amount of apparatus which supplements that owned by the Station. After the present year another laboratory room containing about 300 feet of floor space will be connected with the general laboratory and fitted up for the exclusive purpose of instruction. The association of the two classes of work has had reciprocal advantages, especially in providing a larger supply of apparatus than either the Station or the University could have readily furnished independently.

EXPERIMENT STATION GREENHOUSE. Fig. 2.

The greenhouses consist of a lean-to, on the same level and directly connected with the general laboratory, having a floor space of 12 by 18 feet, and facing the south. Beyond this room is another, a little larger, running at right angles, with a short span to the east. The rooms are heated with steam from the boiler which supplies the laboratories and offices of the Station building, and through pipe radiators of the usual pattern, placed against the walls. There are two radiators in each room, which may be used independently; and to further control the amount of heat, four of the six pipes of each radiator are supplied with manifold valves, so that each can be shut off, or turned on, independently of the others. An electrical apparatus for the automatic control of the steam is also in place, and is used at times. The two rooms are kept at the same, or at different temperatures, as required for the experiments at hand.

The houses are fitted with side benches, and in the lean-to portion a tier of shelves has recently been put in, rising against the brick wall forming the north side, which gives a large amount of available space, and brings the plants nearer to the light. In the other room the principal bench is 3¾ feet wide by 19 feet long, and for three years was fitted with a system of subirrigation, made of three-inch tiling, having the joints covered with mortar. The water was run into it at one end and escaped through the walls of the tiling and through cracks, an opening at the farther end permitting an overflow, if too much

water were introduced. This worked fairly well, but for purposes of experiment was too uneven in distribution of the water and in the space occupied by the tiling.

The subirrigation system now in use, put in place in September, gives perfect satisfaction. The bench has a water tight zinc lining over the bottom, and extending three inches up the sides. In this pan are laid common soft building brick, placed close together on edge. The soil is added, and treated in the usual manner. Water is introduced through small pipes in the front edge of the bed, and the overflow escapes through openings at suitable heights in the back side of the bed. A crop of lettuce grown on this bench has required no overhead watering, and the soil remains in a strikingly porous and friable condition, especially favorable to plant growth.

The vegetation house was erected in 1893. It is a glass and wood structure, 20 by 50 feet in size, with the whole north side occupied with doors 10 feet high. Tracks extend across the house, under each door and beyond for 60 feet. Two trucks, each with a platform of 2½ by 7 feet, are allotted to each track, and on these the plants for the experiment are placed. The plants are kept in the open air in favorable weather, but on the approach of storms or chilly weather are run into the house. No provision is made for artificial heat, and the house is chiefly used in summer. In the larger number of experiments the plants are grown in zinc cans having an opening by which they may be watered from the bottom. Most excellent results have been obtained by this method of experimentation; and the vegetation house is considered one of the specially valuable appliances of the department for securing uniformity of conditions for the growth of plants under experiment.

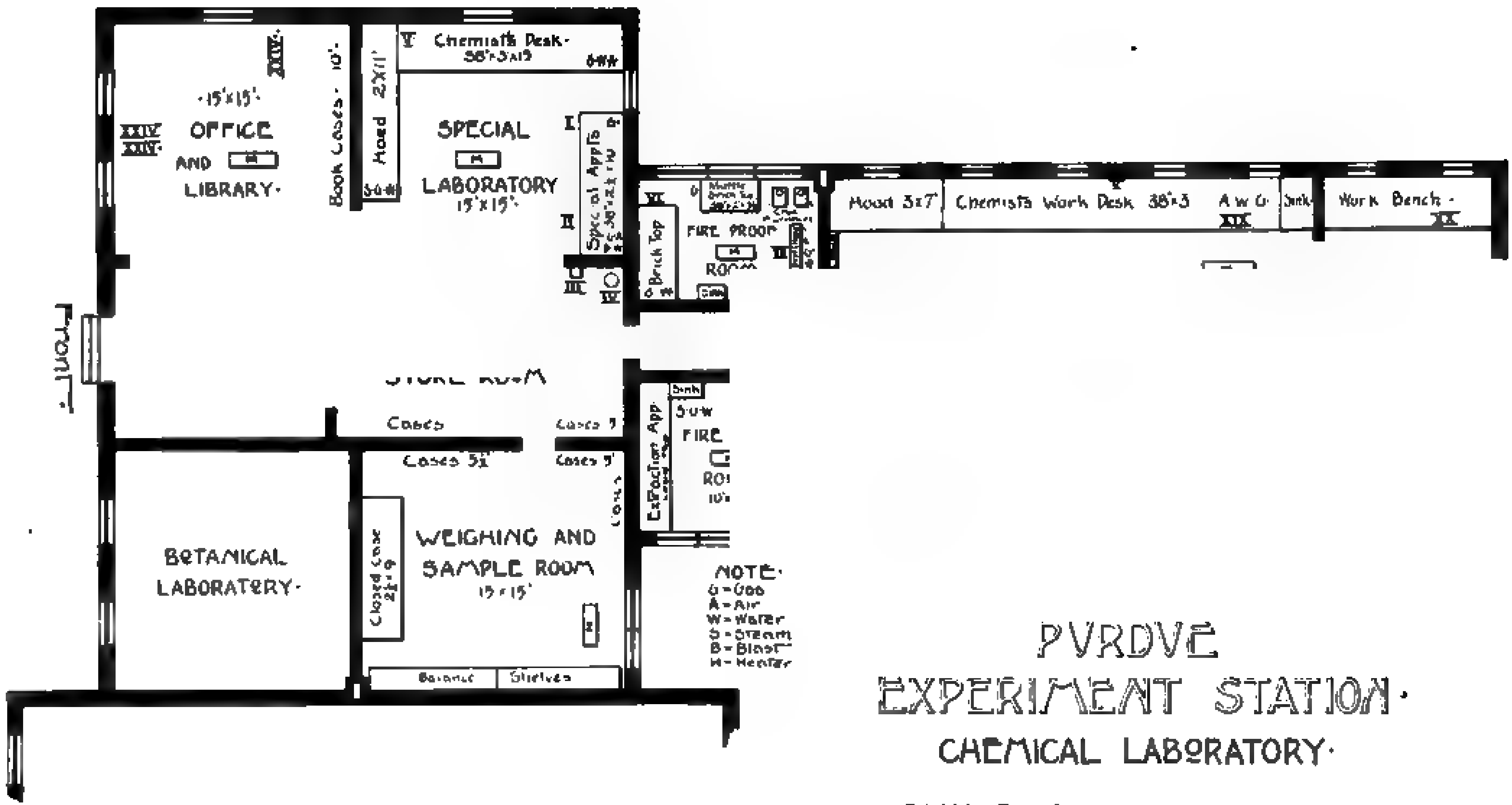
The open ground used by the department is a very necessary part of the equipment. In it are tried many experiments that have had their preliminary tests in the greenhouse, vegetation house or laboratory. Quite a number of species of shrubs and suffruticose and herbaceous perennials are kept at hand, which in various ways lend themselves to observation and experiment in connection with many subjects of inquiry. The garden also receives the overflow of the greenhouse during the warm months, and on the other hand serves as a place for starting plants destined for winter use.

VEGETATION HOUSE, TRUCKS AND POTS.

The botanical department of the Station is fitted for a wide range of experimental work, but the amount of assistance available requires that the main part of the labor be restricted to a few lines of inquiry, which so far have fallen partly in the domain of pathology and partly in that of physiology.

Respectfully submitted,

J. C. Arthur,
Botanist.



FLOOR PLAN OF CHEMICAL LABORATORY. Fig. 3.

REPORT OF THE CHEMICAL DEPARTMENT.

To C. S. Plumb, Director:

SIR—The following is a summary of the work of the Chemical Department for the year 1896:

DESCRIPTION OF THE CHEMICAL LABORATORY.

During the past year the Laboratory has been removed from the second floor to the first floor of the east wing of the Station building, and the south wing formerly used for storage has been finished and equipped for a Laboratory. The plan of the new Laboratory is shown in Fig. 3 It consists of nine rooms conveniently arranged for chemical work. The basement under the east wing is also used for storage. The desks aggregate 200 feet in length against 60 in the old Laboratory, and the floor space and storage room has been increased in even greater proportion. This permits a considerable space to be devoted to apparatus, which is permanently mounted, and saves much time and risk of breakage in constantly fitting up and dismounting apparatus. All permanent apparatus is supported from above as shown in plate III, and any piece of apparatus, however complex, can be removed without dismounting it or separating its parts by simply unscrewing the nut on the overhead support. Desks are equipped with gas, water, vacuum, air pressure and live steam.

Two fire proof rooms are provided for work with materials of inflammable nature, and water, steam and gas connections are carried out through the side wall to provide for specially dangerous work being conducted outside the building.

The changes made in the Laboratory and the removal to new quarters seriously interfered with the laboratory work during the summer months. But the improved facilities for work, and the increased safety of men and property, far more than offset this.

Index to Permanent Apparatus.

(*See Fig. 3.*)

I. Apparatus for carbonic acid determinations.
II. Stills for ammonia, fatty acids, etc.
III. Telephone.
IV. Washstand.
V. Air pumps.
VI. Combustion furnaces.
VII. Kjeldahl distilling apparatus.
VIII. Coils for drying green fodder, etc.
IX. Glass blowing table.
X. Titration apparatus.
XI. Fiber apparatus.
XII. Apparatus for drying in hydrogen.
XIII. Constant temperature drying ovens.
XIV. Special digestion apparatus with tanks.
XV. Motors overhead, blast lamps and shafting on desk, force pumps below.
XVI. Stirring apparatus.
XVII. Humus apparatus.
XVIII. Distilled water apparatus.
XIX. Baths for phosphoric acid work.
XX. Tools.
XXI. Mills.
XXII. Sampling table.
XXIII. Glass tubing racks.
XXIV. Office desks.
XXV. Coat racks.

Fertilizer Experiments on Clay Soils.

In the spring of 1896 I visited southern Indiana for the purpose of selecting suitable land for conducting fertilizer experiments with special reference to clay soils of different types. The people of that section of the State manifested a lively interest in the matter, and plats of land on the farms of Messrs. B. F. Turley and William Burton were selected in Orange County and a plat of land on the farm of Mr. George P. Campbell, in Monroe County. The crop on all these lands was corn, and the season was particularly favorable for the crop. I attended personally to the platting of the ground, the application of the fertilizers, and the weighing of the crops after the harvest. Several visits of inspection were made to the fields during the summer.

The results of the fertilizers were well defined and will appear in bulletin form. The lands were put in wheat this fall

and the fertilizer tests were extended to cover more points in regard to sources of phosphoric acid and methods of application. The Station is under many obligations to Mr. B. F. Turley and Mr. Joe A. Burton, of Orleans, and Mr. George P. Campbell, of Bloomington, for their valuable assistance and hearty co-operation in the work.

The greater quantity of fertilizers used in the State is applied to the southern counties, and it seems desirable to conduct further experiments on crops in rotation in order to obtain the data necessary to give farmers reliable information in regard to the needs of typical soils of that section.

In connection with the fertilizer work on corn, an experiment on a very limited scale was made on apples trees in the orchard of Mr. J. A. Burton. One of these experiments was made on a tree infected with root rot, and the treatment caused a new bark to form on the diseased root crown. This was a matter of much surprise to those familiar with the disease. As the disease is causing widespread injury to trees in that section, the work will be continued on a much larger scale the coming season.

Laboratory Studies of Available Plant Food in Soils.

When the Station was established samples of soil and subsoil were drawn from all the experimental plats. At the end of five years another set of samples was taken. Considerable work was done comparing these sets of samples by the ordinary methods of analysis. No satisfactory results were obtained showing either effects of cropping or effects of application of fertilizers. An attempt was made to devise methods especially adapted to determination of available plant food. For this purpose the principle of soil absorption was used as a basis for the work on available potash, the solubility of phosphates of iron and alumina as the basis of work on phosphoric acid, and the determination of the nitrogen content of humus (suggested by Hilgard) as the basis of the work on nitrogen.

In addition to the Station soils with known history, I obtained, through the courtesy of Dr. A. M. Peter, of the Kentucky Station, samples of soils from four plats of the Kentucky Station. These soils had been used for the investigations of the soil reporters of the Association of Official Agricultural

Chemists, and in addition to giving us a soil of a different type with known history, they afforded samples on which very extensive analytical investigations had been conducted. Two of the soils of southern Indiana, which are from the farms under experiment for the fertilizers work mentioned above, were also included in the work. Thus we had four types of soil all of which were under field tests.

The results of this work have been most encouraging, and I believe we have methods of obtaining the availability of plant food in soils that are superior to any heretofore proposed. The results of this work are ready for publication.

Medicated Cattle Foods.

A number of medicated cattle foods were collected and analyses of them have been completed. The analyses show that the price charged is very far in excess of the feeding value. Sometimes the price of a given weight of the food is in excess of the price of an equal weight of the highest priced medical ingredients contained in the mixture. The results of these examinations only serve to confirm the opinion that it is better, from either the financial or the health standpoint, to buy food and medicine separately.

Cheese.

A number of samples of cheese were examined with special reference to the detection of filled cheese. Several samples were found to be filled. One purpose of the work was to test the reliability of methods used for the purpose. It was found that with proper precautions there was no difficulty in detecting with certainty the presence of the fats ordinarily used in filling cheese. The saponification of the fat presents some difficulty in certain cases. This can be overcome by the use of the alcoholic saponification methods.

The removal of the fat from cheese presents some difficulty when ether and petroleum distillates are used. A method in which the casein was removed by digestion with pepsin solution was devised and found to be rapid, cheap and very efficient.

A CORNER OF THE VETERINARY LABORATORY.

PERMANENT APPARATUS DESK, CHEMICAL LABORATORY.

Sugar Beets.

The work on sugar beets was continued. This year the plats were so located that irrigation could be resorted to in case the rainfall was deficient. The rainfall, however, proved ample. The beets were not of high sugar content owing to the prolonged warm weather of the autumn months.

Persimmons.

The work on persimmons reported as in progress one year ago was completed, and the results have already appeared in Bulletin No. 60.

Miscellaneous.

The usual number of miscellaneous materials has been received for examination. Perhaps the only one of general interest is an ash from a garbage crematory at Evansville. Analysis showed it to contain total phosphoric acid 6.86 per cent., and potash 7.50 per cent. The material would possess considerable fertilizing value, especially for lands needing potash, and the potash is in the most desirable form for such crops as tobacco. No soluble phosphoric acid was present in the material.

During the past year I have been called upon to address a larger number of Farmers' Institutes than in previous years. The farmers seem to appreciate the fact that they can meet the members of the Station staff in this way, and advice is asked on many subjects beside those on the institute program. Attendance at institutes has been the means of calling attention to matters of importance, in which the Station may be of service to the agricultural interests, but which would not have come to our knowledge had we not been present in the localities where such information was needed.

Mr. J. M. Barrett has continued to act as assistant in the Chemical Department, and his services have been eminently satisfactory. Very respectfully submitted,

H. A. HUSTON,
Chemist.

REPORT OF THE HORTICULTURAL DEPARTMENT.

To C. S. Plumb, Director:

SIR—The past season has been, on the whole, a very favorable one for the work in horticultural lines. During the early part of the season—March and April—the amount of rainfall was somewhat below the average, being only 1.14 inches in March and 2.65 inches in April. After this, however, the rainfall was well distributed throughout the season; in fact, during July and August the precipitation was much above the average for those months during previous years. This enabled plants of all kinds to make a steady and rapid growth throughout the season. The temperature during the early part of the season was considerably higher than normal, so that all kinds of fruits and vegetables made a very rapid growth, and ripened about two weeks earlier than usual.

The first strawberries were ripe on May 16, raspberries on June 7, and the Early Harvest blackberries were ready to pick on June 16, which is fully two weeks earlier than the usual time of ripening. The crop was unusually fine.

As was stated in my report for 1895, the greater portion of the Russian apples which were planted ten years ago are not adapted to a climate so far south as this, and so, during the past season, a portion of the trees were top worked with the following varieties, which were received from the United States Department of Agriculture, Washington, D. C.: Millroy's Favorite, Queen of the West, Bloomfield, York Imperial, Staymen, Winesap, Avera, Alabama Pippin, Elston, Pilot, Abraham, Minkler, Jackson, Benninger, Senator, Ontario, Hedrick Sweet, Snyder, Celestia, Great Bear, McIntosh Red, Oglesby, Bonum, Nero, Arnold, Red Carver, Bethlemite, Palouse, Upp, Bancroft, Gem Sweet, Otoa, Virginia Beauty, Rittenhouse, Seek-no further (from York, Pa.), Gerard, Lily of Kent, Dixon, Shiawasse, Brown

Mammoth, Stringtown, Mumper, York Stripe, Nordhouse and Lankford. It is the intention to top work all of these trees as soon as it is possible to do so.

Notes on Cherries.

The following nineteen varieties of cherries fruited this season, and while a few of them are of superior quality and warrant further trials, the most of them are in no way superior to the old Early Richmond. Spate Amerelle is medium size, bright red, tough skin and of fair quality, ripens June 25; Brusseler Braune is large, of dark color, stem two inches long and of very fine quality, and ripens June 25; Ostheim is large, rather dark color, ripening June 16; Montmorency Extraordinary is of medium size, bright red color, short stem and good quality, and ripens June 10; Fouhe Morello is large, bright red, with a short stem, fine quality, and ripens June 8; Montmorency is large, bright red color, ripening June 22. This is one of the best on the list. Wragg is medium size, dark red color and good quality. The tree is low and spreading, and ripens June 25. French Morello is large, dark color, good quality; tree an upright grower; ripens June 25. Lutovka is large, bright red, deep suture, stem 1½ inches long, fine quality and ripens June 10. So far this variety has been a very shy bearer, otherwise it is an excellent variety. Dye House is another medium sort, no better than many others Griotte Du Nord is large, dark color, long stem and good quality; it ripens June 20. Double Natte is medium in size, bright red in color, ripens June 8, and no better than many others. Carnation is a sweet cherry, very large, bright red, rich and meaty and ripens June 8; this is one of the best. Wier No. 2 is only medium in all respects. Bessarabian is medium in size, bright red, long stem (two inches), very good but not prolific. Cerise De Ostheim is medium size, dark red, long stem, very good quality; much like Bessarabian but much more productive; ripens June 20. Frauendorfer is medium size, dark red, medium stem, not productive; ripens June 25.

Plums.

Among our native plums the Wolf and Robinson have given the best satisfaction. The Burbank is unquestionably the best of the Japanese variety for this climate. Among the European class which fruited this season, the Communia was the most productive, while the Yellow Aubert is the largest and finest in appearance. It, however, is very subject to rot, so that it is with great difficulty that a crop is secured in good condition. The other varieties which fruited do not seem to be superior in any respect to many of our old well known varieties.

Dendrolene as an Insecticide.

Among other things which have been sent to this department for trial was a package of Dendrolene, sent by the Bowker Fertilizer Co., of Boston. They asked that it be given a thorough trial on various kinds of fruit and shade trees, for the purpose of determining its effectiveness in keeping out borers and other noxious insects and also as a protection against mice and rabbits. The material was applied to a number of young healthy stock trees of Champion, Crosby and other varieties of peach and also to a number of the same varieties bearing their first crop of fruit. A number of young apple trees, just transplanted, were also coated. The material was applied in May, according to directions, by coating the trunks of some trees from the ground to the lower limbs, and to others only about half way up. On examination about the middle of August, it was found that several of the young peach trees were beginning to drop their leaves and to show signs of general debility. A little later the older trees began to show signs of trouble, and on making a careful examination of the trees about the first of September, it was found that the material had been absorbed by the bark to such an extent as to shut off the circulation of sap completely, and that the inner bark or cambium had turned black and was apparently dead. The same was true to a somewhat less extent in case of the young apple trees, so that a month later every peach tree and most of the apple trees to which the material was applied were dead.

The results from these experiments and information which I have received from other sources have led me to conclude that the material in its present form is not safe to use on young peach trees in this section, and I would not recommend its use on any tree until we have had an opportuity to test it more fully.

Close Root pruning Trees.

The question of close root-pruning trees has been attracting the attention of fruit growers and nurserymen of late, especially in the southern States. In order to ascertain whether this method would be suitable to this climate or not, an experiment was planned last spring, by which four trees each of standard and dwarf pears, cherry, prune, peach and quince were selected for trial. Two trees each of these varieties were pruned so that not more than an inch or two of the roots remained, and the tops were entirely removed. The remaining two were planted in the ordinary way. These trees were all photographed before planting, and after having grown during the season, they were all taken up and photographed again. The result of this experiment showed that the peach was capable, after being deprived of all its roots and branches, of producing a magnificent root system and a top to correspond. The Dwarf pear, Standard pear, German prune and Early Richmond cherry came next in order. The latter making very little root development on the pruned trees.

It should be borne in mind that the season was an exceptionally favorable one for this experiment. A dry season might produce entirely different results; for that reason the experiment will be continued for a series of years.

Bees vs. Grapes.

Many fruit growers are firm in the belief that honey bees do great damage to the grape crop during the ripening period, by cutting the skin and sucking the juice. I have not been able to find where any definite experiments on this subject have been conducted; so during the latter part of August, as the Worden grapes were beginning to ripen, a colony of bees was placed close to a grape vine, and mosquito netting stretched

over both vine and bees, so as to allow plenty of room for flying about, but not allowing the bees to get outside where they could gather food. They were kept confined for three weeks, and in the meantime the grapes had become thoroughly ripe; but by making close observations at different times during the period, not a grape was found to have been punctured. Outside the inclosure wasps were very busy cutting the skin of grapes and sucking the juices. We conclude, therefore, that in the absence of wasps the grape grower will suffer but little, if any, from this cause.

Other Experiments Begun.

Last September this department received a request from the Chief of the Division of Forestry, Department of Agriculture, Washington, D. C., to co-operate with other experiment stations in an investigation having for its object a study of the effect of locality on forest tree seedlings. In commencing this experiment we have already received a large number of seeds of different varieties of forest trees from twenty one different States and Territories. These seeds will be planted the coming spring and the results carefully watched.

This department also has under way among other things an experiment having for its object a study of bud variation on the branch, and also by its position on the tree.

Very respectfully submitted,

JAS. TROOP,
Horticulturist.

CLASS
ROOM

FLOOR PLAN OF VETERINARY LABORATORY. Fig. 4.

REPORT OF THE VETERINARY DEPARTMENT.

To C. S. Plumb, Director:

SIR—I herewith submit a report of the work of the Veterinary Department for the year 1896.

Hog Cholera and Swine Plague. The first work was the completion of Bulletin No. 59, upon "Hog Cholera and Swine Plague in Indiana," published in February. The bulletin deals largely with the sanitary measures to be employed in checking this disease. Studies have been conducted along the same lines during the year, to learn still more of preventive measures, especially those that might be employed by all farmers in protecting their stock. The observations recorded in the bulletin have been corroborated to a large extent through reports which were received quarterly from about 150 correspondents. These settle in a certain degree some of the disputed points concerning the season when the disease is most prevalent, causes, etc.

An inquiry was also conducted relative to the spread of disease by exhibition at State and county fairs. A letter was addressed to each exhibitor at the Indiana and Ohio State fairs and to a large number of exhibitors at the county fairs. The result of this correspondence leaves no doubt as to the danger that may arise from such exhibitions, and also the importance that should be attached to disinfection of pens at these fairs. Upon my report to the State Swine Breeders' Association, a recommendation was made by them to the Legislature to enact a law to require disinfection of exhibition pens by fair associations.

A complete study of the distribution of the disease, by counties from 1882 to 1890 and by townships for 1895 and 1896, has also been made. These have been plotted on maps and are ready for publication. As this is the most destructive disease in the State, it is worthy of special study. The loss in 1895 was $3,250,000.

Tuberculosis. The bulletin upon tuberculosis, issued in December, embraces the study made upon that disease.

Actinomycosis, or lumpy jaw, was treated in ten head of cattle. The treatment consisted of doses of a drachm to a drachm and a half of iodide of potash once a day for two weeks, and a repetition at the end of one week in those cases in which it was necessary; 80 per cent. made recovery.

An extended study of the bacteria in stables was made during the first half of the year. This work was largely done by Mr. Charles E. Davis, a senior student. Eighteen forms of bacteria are described in detail and a full account is given of the conditions under which the germs and number of germs were taken. As a preliminary study upon stable hygiene, the work had considerable value.

A number of other problems, such as the treatment of fistula and poll evil, the testing of new remedies, as antiseptics and disinfectants, a new spaying fluid (?), hog cholera cures, etc., were conducted as far as time would permit.

An attempt was also made to collect statistics from Veterinarians upon the occurance of disease during the year. During the first six months the reports were quite satisfactory, and summaries were published. During the last half, the reports were too irregular to give all the value to the work that is desired and a report has not as yet been published. These reports are of considerable value as indicating the number of cases occuring at different seasons of the year and under different conditions. The work will be continued, using a different system of collecting data, which it is hoped will result in greater success.

The department has been called upon to do a large amount of Institute work and to give addresses before county and State breeders' associations. The requests, in many cases, have been denied, as the duties in the class room and laboratory are of primary importance.

The improvement in the quarters for the department during the past year have been greater than at any previous time since its establishment. The rooms now occupied are sufficient for most of the purely laboratory research work. The department occupies the second floor in the east end of the Experiment Station building. Six rooms comprise the suite; office, laboratory, room for microscopy, transfer room, dark room

and specimen room. The last mentioned is connected with the class room and is used more for college purposes than for Station work.

The office room is about 11½ feet by 15 feet and contains a part of the Station library on Veterinary Science, and the private library and card index belonging to the head of the department. The library is particularly strong in journalistic literature, and an attempt has been made to procure a complete file of all veterinary journals published in English from 1825 to date. The effort has only been partially successful, as a few volumes and numbers are not obtainable. The card index numbers over 30,000 references to veterinary literature. While these are private property, the Station has had their usage.

The Laboratory is 15 feet by 18¼ feet. It is fitted with the usual tables and a hood. Space is economized as far as possible by fitting the under part of the tables with drawers and closets. The tables are piped with gas, water, steam and air. Cases and shelves utilize all available wall space. The Laboratory is fitted with the usual appliances for all ordinary work in pathology and bacteriology. A Zeiss microscope of late pattern with full complement of eye pieces and objectives, a Bausch and Lomb laboratory microtome with a carbonic acid freezing attachment, baths, ovens, steam and dry sterilizers, culture apparatus for bacteriological work, centrifuge and a full line of imbedding and staining reagents, etc.

The room for microscopy is small, only about six and a quarter by nine feet, but well suited for the purpose.

The transfer room is separated from the microscopic room by a glass partition. It is four and three-quarters by nine feet and is provided with the usual glass-top table and a constant temperature oven.

The dark room is 6 feet 10 inches by 16 feet 10 inches, and is well equipped for the work. A large camera, 6½ by 8½ inches, provided with rectilinear and wide angle lenses, and a smaller camera, 4 by 5 inches, with a rectilinear and a wide angle lense, are at the disposal of the Station. Special apparatus for photomicrography has been devised in the department, so that the equipment permits a wide range of record work.

The museum room is about 12 by 17 feet. It connects the department with the class room, and is used largely for storing

material for class room demonstration. It is also used for storing all pathological material used in Station studies. The surgical instruments, of which there is a very full line, are kept here.

The hospital building is inadequate for any experimental work, except the simplest kind. It serves as a protection for guinea pigs and rabbits during the winter, and for experiments where only one or two animals are employed. Until a suitable building for this branch of the work is provided, the work of the department will be greatly handicapped.

The illustration on page 49 shows the general floor plan of the office, laboratory rooms, etc.

Respectfully submitted,

A. W. Bitting, D. V. M.,
Veterinarian.

APPENDIX.

ACKNOWLEDGMENTS.

The following gifts have been made to the Station during the year, and to the givers of these thanks are herewith rendered:

United States Department of Agriculture, Washington, D. C. Numerous publications, seeds, etc.

A. G. Young, Register, Augusta, Maine. Maine Registration Report for 1893.

D. McAlpine, Botanist, Department of Agriculture, Victoria, Australia. One copy, "The Systematic Arrangement of Australian Fungi, together with Hrost index and list of works on the subject," by D. McAlpine.

Patterson Parchment Co., Passaic, N. J. 1,000 sheets parchment paper for butter prints.

Polar Creamery Co., LaFayette, Ind. One floating bulb thermometer. Repairs to creamer.

W. Atlee Burpee, Philadelphia, Pa. Packages of flower and vegetable seeds.

O. C. Gregg, Superintendent, Minneapolis, Minn. One copy of Eighth Annual Report Minnesota Farmers' Institutes.

B. W. Chipman, Secretary, Halifax, Nova Scotia. Annual Report of the Secretary of Agriculture for Nova Scotia for 1895.

Edwin Taylor, Secretary, Topeka, Kansas. Fourth Annual Report of the Kansas Horticultural Society for 1894–95.

F. Barteldes & Co., Lawrence, Kansas. One-fourth pound white Kafir corn seed.

C. W. Bush, Granville, Ill. One peck of Early Jewell oats.

Richard Nott, Burlington, Vt. Sample Nott's No. 96 pea.

F. D. Coburn, Secretary, Topeka, Kansas. Numerous reports of the Kansas State Board of Agriculture.

Librarian Oberlin College, Oberlin, Ohio. Bulletins of Oberlin College.

F. W. Kirk, Biologist, Wellington, New Zealand. Reports from the New Zealand Department of Agriculture.

William Weld & Co., London, Ontario, Canada. Copy engraving "Canada's Glory."

West Disinfecting Co., New York City, and J. C. Tarkington, Agent, Indianapolis, Ind. Chloro-Naptholeum.

N. W. Ayer & Sons, Philadelphia. One copy of the "Manual for Advertisers."

Prof. W. P. Brooks, Amherst, Mass. Seeds of Japanese millet and soy beans.

B. F. Albaugh & Son, Covington, Ohio. Basket of plants.

John K. King, Coggeshall, Essex, England. Seventeen sample packages of cabbage, tomato, radish, beet and mangel seed.

James Riley, Thortown, Ind. Three quarts Riley's Favorite and three quarts of Boone County White seed corn.

Bowker Fertilizer Co., Boston, Mass. One pail (20 pounds) dendrolene.

Gale Manufacturing Co., Albion, Mich. One No. 11 Albion Steel Cultivator.

W. W. Miller, Secretary, Columbus, Ohio. Reports of the Ohio State Board of Agriculture from 1886-1895 inclusive.

Chas. F. Kennedy, Secretary, Indianapolis, Ind, Annual Report Indiana State Board of Agriculture.

I. M. Kellogg, Ionia, Mich. Automatic runner cutter. Perfection plant setter. Twenty-five plants each of twelve varieties of strawberries, seven varieties raspberries, three of blackberries and two of currents.

J. D. Frederickson, Little Falls, N. Y. One box Champion carrot seed and one box Jersey Giant parsnip seed.

Deming Co., Salem, Ohio. One spraying nozzle.

Mortimer Levering, LaFayette, Ind. One private flock register.

Henry A. Dreer, Philadelphia, Pa.; James Vick's Sons, Rochester, N. Y.; Jos. Breck & Sons, Boston, Mass.; Peter Henderson & Co., New York City; Jas. Veitch & Sons, Chelsea, S. W., London, England; B. S. Williams & Son, Upper Holloway, London, N., England; William Bull, Chelsea, London, England, and Ernest Benary, Erfurt, Germany. Packages of seeds of cineraria and calceolaria.

German Kalin Works, New York City. One bag each of muriate and sulphate of potash.

W. R. Sessions, Secretary, Boston, Mass. Report Massachusetts State Board of Agriculture for 1895. Report on "The Gypsy Moth for 1896."

Fred C. Schraub, Commissioner, Albany, N. Y. Second Annual Report of the Commissioner of Agriculture.

William Trelease, Director, St. Louis, Mo. Report of the Missouri Botanic Gardens for 1896.

L. A. Goodman, Secretary, Westport, Mo. Thirty-eighth Annual Report Missouri State Board of Agriculture for 1895.

Chas. P. Lounsbury, Entomologist, Cape Town, South Africa. Report of Government Entomologist for 1895.

Prof. C. A. Zavitz, Guelph, Ontario. Three pounds of Dawson's Golden Chaff Wheat.

Mosure & Co., Vera Cruz, Ind. One Magic post hole digger.

S. C. Bassett, Secretary, Gibbon, Neb. Report for 1895 of Nebraska Dairymen's Association.

Dr. F. B. McNeal, Commissioner, Columbus, Ohio. Report Ohio Dairy and Food Commissioner for 1895.

Hon. John Dryden, Minister of Agriculture, Ottawa, Ontario, Canada. Numerous agricultural reports.

Herd Books.

Mortimer Levering, Secretary, LaFayette, Ind. Vol. II American Shetland Stud Book, and Vol. II of the American Shropshire Sheep Record.

W. A. Shafor, Secretary, Middletown, Ohio. Vol. VI American Oxford Down Sheep.

J. McLain Smith, Secretary, Dayton, Ohio. Vol. VII of the Red Polled Herd Book.

J. H. Miller, Secretary, Peru, Ind. Vol. I American Polled Durham Herd Book.

N. R. Pike, Secretary, Winthrop, Maine. Vol. VIII of the Maine State Jersey Cattle Association.

C. R. Thomas, Secretary, Independence, Mo. Vol. XV of the American Hereford Record.

W. H. Caldwell, Secretary, Peterboro, N. H. Vol. for 1896 of the American Guernsey Cattle Club.

Carl Friegau, Secretary, Dayton, Ohio. Vol. XVIII Ohio Poland-China Record.

George F. Woodworth, Secretary, Maryville, Mo. Vols. I–IX Standard Poland-China Record.

Periodicals.

The publishers of the following periodicals have kindly sent them to the Station during the year. These are leading journals, and are used for frequent consultation, both by the Station staff and the agricultural students of the University:

UNITED STATES.

Agricultural Epitomist	Indianapolis, Ind.
American Creamery	Chicago, Ill.
Agricultural Student	Columbus, Ohio.
American Cultivator and Poultry Keeper	Los Angeles, Cal.
American Fertilizer	Philadelphia, Pa.
American Florist	Chicago, Ill.
American Gardening	New York, N. Y.
American Grange Bulletin	Cincinnati, Ohio.
American Horticulturist	Wichita, Kan.
American Sheep Breeder and Wool Grower	Chicago, Ill.
Baltimore Sun (weekly)	Baltimore, Md.
Breeders' Gazette	Chicago, Ill.
Call (weekly)	San Francisco, Cal.
Colman's Rural World	St. Louis, Mo.
Creamery Journal	Waterloo, Iowa.
Drainage Journal	Indianapolis, Ind.
Elgin Dairy Report	Elgin, Ill.
Experiment Station Record	Washington, D. C.
Farm and Dairy	Ames, Iowa.
Farm and Fireside	Springfield, Ohio.
Farm and Home	Chicago, Ill.
Farm, Field and Fireside	Chicago, Ill.
Farm Journal	Philadelphia, Pa.
Farm Poultry	Boston, Mass.
Farmers' Call	Quincy, Ill.
Farmers' Guide and Home Companion	Huntington, Ind.
Farmers' Home	Dayton, Ohio.
Farmers' Magazine	Springfield, Ill.

Farmers' Review	Chicago, Ill.
Field and Farm	Denver, Colo.
Grange Visitor	Lansing, Mich.
Hoard's Dairyman	Fort Atkinson, Wis.
Holstein-Friesian Register	Brattleboro, Vt.
Home and Farm	Louisville, Ky.
Indiana Farmer	Indianapolis, Ind.
Industrial American	Lexington, Ky.
Industrialist	Manhattan, Kan.
Iowa Homestead	Des Moines, Iowa.
Jersey Bulletin	Indianapolis, Ind.
Journal of Agriculture	St. Louis, Mô
Kansas Farmer	Topeka, Kan.
Live Stock Journal	Indianapolis, Ind.
Live Stock Report	Chicago, Ill.
Market Garden	Minneapolis, Minn.
Michigan Farmer	Detroit, Mich.
Mirror and Farmer	Manchester, N. H.
Montana Fruit Grower	Missoula, Mont.
National Stockman and Farmer	Pittsburgh, Pa.
Nebraska Farmer	Lincoln, Neb.
New England Farmer	Boston, Mass.
New England Florist	Boston, Mass.
New York Produce Review	New York, N. Y.
Ohio Farmer	Cleveland, Ohio.
Orange Judd Farmer	Chicago, Ill.
Oregon Agriculturist	Portland, Oregon.
Pacific Coast Dairyman	Tacoma, Wash.
Pacific Rural Press	San Francisco, Cal.
Practical Dairyman	Chatham, N. Y.
Practical Farmer	Philadelphia, Pa.
Prime's Crop Bulletin	Dwight, Ill.
Progressive South	Richmond, Va.
Public Ledger (daily)	Philadelphia, Pa.
Reliable Poultry Journal	Quincy, Ill.
Rural Northwest	Portland, Oregon.
Silent Hoosier	Indianapolis, Ind.
Southern Cultivator and Dixie Farmer	Atlanta, Ga.
Southern States	Baltimore, Md.
Southern Farmer	New Orleans, La.
Success with Flowers	West Grove, Pa.
Sugar Beet	Philadelphia, Pa.
Wallace's Farmer and Stockman	Des Moines, Iowa.
Weather and Crops	Chicago, Ill.
Western Soil Culture	Minneapolis, Minn.
Wisconsin Agriculturist	Racine, Wis.

FINANCIAL STATEMENT.

The Agricultural Experiment Station of Indiana in account with the United States, for year ending June 30, 1896.

DEBIT.

Received of Treasurer of the United States—Receipts as shown by the Treasurer's report		$15,000 00

CREDIT.

Salaries	$8,197 70	
Labor	3,049 30	
Publications	1,523 34	
Postage and stationery	143 59	
Heat, light and water	401 50	
Seeds, plants and sundry supplies	478 92	
Feeding stuffs	292 06	
Library	171 92	
Tools, implements and machinery	179 64	
Chemical supplies	156 23	
Freight and express	88 16	
Fertilizers	26 24	
Furniture and fixtures	23 85	
Scientific apparatus	39 20	
Live stock	76 75	
Traveling expenses	46 15	
Contingent expenses	31 61	
Building and repairs	73 84	
Total		15,000 00

I hereby certify that the above is a correct statement of expenditures in Station fund for year ending June 30, 1896.

E. A. ELLSWORTH,
Secretary Board of Trustees.

IMPROVEMENT FUND EXPERIMENT FARM FOR YEAR ENDING JUNE 30, 1896.

DEBIT.

Balance June 30, 1895		$1,148 23
Receipts from farm for 1896		1,091 02

CREDIT.

Salaries	$392 02	
Labor	422 72	
Heat, light and water	125 00	
Publications	23 20	
Postage and stationery	10 35	
Freight and express	26 18	
Seeds, plants and sundry supplies	62 72	
Feeding stuffs	14 00	
Tools, implements and machinery	19 08	
Furniture and fixtures	10 75	
Scientific apparatus	26 44	
Live stock	10 90	
Traveling expenses	26 95	
Contingent expenses	83 00	
Building and repairs	55 31	
Balance	930 63	
	$2,239 25	$2,239 25

I hereby certify that the above is a correct statement of expenditures from improvement fund for year ending June 30, 1896.

E. A. ELLSWORTH,
Secretary Board of Trustees.

PURDUE UNIVERSITY

TENTH ANNUAL REPORT

OF THE

AGRICULTURAL EXPERIMENT STATION

LAFAYETTE, INDIANA.

1897.

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.
1898.

THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
INDIANAPOLIS, March 3, 1898.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF AUDITOR OF STATE,
INDIANAPOLIS, March 4, 1898.

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

A. C. DAILY,
Auditor of State.

MARCH 5, 1898.

Returned by the Auditor of State with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

CHAS. E. WILSON,
Private Secretary.

Filed in the office of Secretary of State of the State of Indiana, March 5, 1898.

W. D. OWENS,
Secretary of State.

Received the within report and delivered to the printer this 5th day of March, 1898.

THOS. J. CARTER,
Clerk Printing Bureau.

GREENHOUSE OF HORTICULTURAL DEPARTMENT.

To the Governor:

I herewith transmit the annual report of the Purdue University Agricultural Experiment Station, due on or before February 1, 1898.

Very respectfully yours,

CHAS. B. STUART,
President Board of Trustees.

January 29, 1898.

To the President of the Board of Trustees:

I herewith present the annual report of the Agricultural Experiment Station of Indiana, due on or before the 1st of February, 1898, the same being required by Section 3 of an act of Congress, entitled, "An act to establish agricultural experiment stations in connection with the colleges established in the several States under provisions of an act approved July 2, 1862, and of the acts supplemental thereto."

This report consists of a report of the Director and other officers of the Station and the financial report of the Secretary to the Board of Trustees.

Respectfully submitted,

J. H. SMART,
President.

Purdue University, Lafayette, Ind., January 29, 1898.

BOARD OF CONTROL.

Charles B. Stuart, President......Lafayette, Tippecanoe County.
William A. Banks...................Laporte, Laporte County.
Sylvester Johnson..................Irvington, Marion County.
David E. Beem......................Spencer, Owen County.
Job H. VanNatta................Lafayette, TippecanoeCounty.
Benjamin Harrison..............Indianapolis, Marion County.
William H. O'Brien..........Lawrenceburg, Dearborn County.
James M. Barrett..................Fort Wayne, Allen County.
John Martin.....................Brookville, Franklin County.

JAMES H. SMART, LL. D.,
President of the University.

EDWARD A. ELLSWORTH,
Secretary.

JAMES M. FOWLER,
Treasurer.

STATION STAFF.

Charles S. Plumb, B. S.	Director.
William C. Latta, M. S.	Agriculturist.
James Troop, M. S.	Horticulturist.
Henry A. Huston, A. M., A. C.	Chemist.
Joseph C. Arthur, D. Sc.	Botanist.
Arvill W. Bitting, D. V. M.	Veterinarian.
Jesse M. Barrett, B. S., A. C.	Assistant Chemist.
William Stuart, M. S.	Assistant Botanist.
William B. Anderson, B. S.	Assistant Agriculturist.

TENTH ANNUAL REPORT

OF THE

Purdue University Agricultural Experiment Station

REPORT OF THE DIRECTOR
AND OTHER OFFICERS.

To President James H. Smart:

Sir—I have the honor to herewith transmit to you the Tenth Annual Report of the Purdue University Agricultural Experiment Station for the year 1897:

Experimental Work. No essential change in the character of the experimental work has taken place during the year, but investigations in certain lines have been intensified and given unusual prominence. In the Chemical Department the sugar-beet investigations have occupied a large amount of attention. The work of the past ten years in this direction has resulted in the Station being called upon for much information during 1897 on sugar-beet questions from the standpoint of both farmer and investor. Anticipating the demand for information concerning Indiana as a field for profitable beet-sugar production, the Station planned and carried out more far-reaching experiments than heretofore. Through the courtesy of the United States Department of Agriculture, 500 pounds of beet seeds were sent to us and distributed in certain localities in the State to farmers who agreed to grow one-fourth acre or

more under Station directions. This work was delegated to the Chemist, who has had personal charge of the sugar-beet investigations from the first. As a result of this work, over 300 samples of beets were tested for sugar content this Fall from 23 different counties. The results of the tests made have already been transmitted to the Secretary of Agriculture at Washington, with whom we are co-operating in the work. A sugar-beet bulletin is now in preparation that will contain the results of the work of 1897, with some cultural instructions. This will be published early in 1898.

In connection with the sugar-beet work it is gratifying to be able to say that much territory in Indiana seems adapted to growing a beet rich in sugar. The Station tests have attracted much interest from both within and without the State, and in several counties, with headquarters at New Castle, Fort Wayne and Hamlet, sugar-beet associations have been formed, and efforts are in progress which it is hoped, will result in the creation of one or more beet-sugar factories in Indiana in the near future.

During 1898 the Station, in coöperation with the United States Department of Agriculture, will distribute a large quantity of beet seeds in certain parts of the State, where the adaptability of this root is yet untried.

Before closing this subject, I wish to call your attention to the fact that this Station has for years been publishing material on the sugar beet, mainly as original investigations. This is shown in the following titles and when published. This list does not include numerous communications furnished agricultural or other journals:

Varieties of Sugar Beets. Bull. No. 18, January, 1889, p. 1.
Varieties of Sugar Beets. Bull. No. 31. April, 1890, p. 1.
Sugar Beets. Bull. No. 34, February, 1891, pp. 10.
Sugar Beets. Bull. No. 39, April, 1892, pp. 10, pl. I.
Diseases of the Sugar Beet Root. Bull. No. 39, April, 1892, pp. 9, pl. I.
The Sugar Beet in Indiana. Bull. No. 43, March, 1893, pp. 16-20.
Sugar Beets. Bull. No. 49, March, 1894, pp. 15-40, figs. 2.
Sugar Beets. Bull. No. 55, March, 1895, pp. 46-54.
The Sugar Beet Question in Indiana. Newspaper Bull. No. 40, Dec. 19, 1896.
Sugar Beet Tests in Indiana. Newspaper Bull. No. 45, April 27, 1897.
Cultivation and Thinning of Sugar Beets. Newspaper Bull. No. 46, June 19, 1897.
The Sugar Beet as a Food for Live Stock. Newspaper Bull. No. 51, November 15, 1897.
Preparation of Ground for Planting Sugar Beets. Newspaper Bull. No. 52, November 22, 1897.

For some years, in both the Chemical and Botanical Departments of the Station, investigations have been made upon the edible fungi found in this region or of a cultivated class. In order to have a field for continuous investigation, in the Fall, a mushroom house was built for growing fungi for the Botanical Department. This was a plank cellar or pit, twenty feet long and eight feet wide, which is entirely covered with soil, and is so ventilated and constructed as to give a very uniform temperature within. It is hoped that this cellar will give satisfactory conditions for fungi studies.

In the Veterinary Department three lines of investigation are of more than passing importance. The subject of tuberculosis among cattle has within the year greatly increased in discussion, until finally it has resulted in the city of Indianapolis requiring all cows supplying milk to that city and within its boundaries to be tested with tuberculin and shown to be free from tuberculosis. The Veterinarian has been frequently in demand, and over 1,000 animals have been tested by the Station up to Jan. 1, 1898, while over 2,000 have been tested by Dr. Bitting or his deputy. The importance of this work is unquestioned, but beyond a desire to secure certain experimental data, I do not regard it as desirable for the Veterinarian to test herds on request, unless the work in question will be of widespread importance. There are plenty of veterinary surgeons competent to attend to such matters. It is gratifying, however, to know that the work of the Station in this field is being recognized and the services of the Veterinarian are in demand in the direction of improved live-stock conditions.

The source, distribution and suppression of hog cholera have also received much attention during the year in continuance of the study of 1896. At the request of Governor Mount, Dr. Bitting did some work along this line during his vacation, which was reported on very late in December. This investigation showed that the losses from hogs dying of cholera amount to $3,500,000 a year, and that much of this is due to improper water supply. On the recommendation of the Veterinarian, a bill was passed by the last Legislature regulating the disinfection of pens on fair grounds and the carrying of pigs from place to place in the State for exhibition, as it had been shown through figures presented by Dr. Bitting that cholera was extensively distributed through the agency of our fairs.

One other important investigation, which involves much origi-

nal research, is a study of milk secretion and the mammary gland. This work has now been continued for over a year, in the veterinary laboratory, on horses and cattle and other domesticated animals, and considerable new information has been secured, which it is hoped will be published during 1898.

Following is given the principal subjects under investigation in the different departments of the Station:

I. CHEMICAL DEPARTMENT.

1. Sugar-beet culture in Indiana.
2. The composition of soils as affected by cropping.
3. The improvement of unproductive black soils.
4. Use of plant food on certain clay soils in southern Indiana.
5. Methods of soil analysis.
6. The composition of feeding stuffs.
7. Miscellaneous determinations.

II. BOTANICAL DEPARTMENT.

1. Influence of plant food on roses grown in pots and the open.
2. Potato scab and its treatment, especially by formalin.
3. Indoor lettuce culture.
4. Corn smut and its prevention by spraying.
5. The bacterial disease of the sugar beet.
6. The relation of size of seed to crop production.
7. Subwatering in the greenhouse.
8. Mushroom culture.
9. Cinerarias and calceolarias for greenhouse and decoration.

III. VETERINARY DEPARTMENT.

1. The distribution of hog cholera in Indiana and its prevention.
2. Testing hog-cholera remedies.
3. The mammary gland and the process of milk secretion.
4. Tuberculosis and the tuberculin test.
5. A study of the fecundity of breeds of swine.
6. The sanitary condition of drinking water for farm stock.
7. Sheep dips and their effect on parasites and wool.
8. Animal diseases in Indiana.

IV. HORTICULTURAL DEPARTMENT.

1. Close root pruning of fruit trees.
2. Whole vs. piece-root grafting.
3. The influence of climate on forest-tree seedlings.
4. New varieties of potatoes and methods of cutting.
5. A study of tomatoes as adapted to canning.
6. Testing varieties of fruit.
7. Greenhouse culture of lettuce and tomatoes.

V. AGRICULTURAL DEPARTMENT.

1. Field experiments on wheat, as involving—
   - a. Test of varieties.
   - b. Weight of seed.
   - c. Distance apart of sowing in drills.
   - d. The application of fertilizers, singly and in combination.
   - e. Rotative cropping.
   - f. Growing clover as an inter-crop each year.
   - g. Effect of soil and climate on foreign varieties.
2. Field experiments on Indian corn, as involving—
   - a. Depth of culture.
   - b. Thickness of stand.
   - c. Period of planting.
   - d. The use of cultural implements.
   - e. Rotative cropping.
   - f. Influence of fertilizers in rotative cropping.
   - g. Effect of planting in furrows.
3. Field experiments on oats, as involving—
   - a. Tests of varieties.
   - b. The adaptability of winter oats to northern Indiana.
   - c. Fertilizer experiments.
4. Tests of grasses and forage plants.
5. Rotative cropping, as shown in corn, wheat, oats, clover and beets.

VI. ANIMAL INDUSTRY.

1. Feeding fattening pigs corn and wheat.
2. Feeding pigs corn meal and corn meal and shorts.

3. Feeding sheep rape in pasture.

4. Combinations of food for growing steers and dairy cows.

5. The relations of food consumption and milk and butter fat production in dairy cows.

Improvements. A few much-needed improvements have been made during the year. The large cattle barn erected in 1889, the residence of the Director and Assistant Agriculturist and the wind pump house and derrick all received two good coats of paint. The old pig buildings, which were located in various lots, that were really unpresentable, were torn down, and neat, small pig houses erected, such as would serve as good models for feeding-lot shelters. What the Station now needs is a suitably constructed pig house for indoor winter feeding experiments. The present accommodations in this line are quite unsatisfactory and inconvenient.

Considerable new fencing was put up last spring, amounting to over 100 rods. Each year some of the old fencing has been replaced by new, until now nearly all of the Station grounds have been refenced and put in good condition, excepting that along the main highway extending west of the Farm House. This will require refencing early in 1898, as for several years it has been at the point of collapsing.

In December a new ten-horse power Van gas engine was purchased jointly by the University and Station and placed in the cattle barn to replace the old six-horse power steam engine and boiler. This new power, we hope, will prove a great addition to our equipment.

Publications. The following are the publications of the Station for 1897. I may say that in addition to these, many agricultural contributions have been made to the press during the year by the writer and other members of the Station Staff:

PAMPHLET BULLETINS.

No. 64, vol. VIII, April, 1897, pp. 16. Field experiments with corn, oats and forage plants. By W. C. Latta and W. B. Anderson.

No. 65, vol. VIII, June, 1897, pp. 17-36, plates I, II. Formalin for prevention of potato scab. By J. C. Arthur.

No. 66, vol. VIII, October, 1897, pp. 38-58, Fig. 1, plates III. IV. Indoor lettuce culture. By William Stuart.

No. 67, vol. VIII, December, 1897, pp. 59-70. Wheat and corn as food for pigs. By C. S. Plumb and W. B. Anderson.

Ninth Annual Report of the Agricultural Experiment Station, 1896, pp. 61, Figs, 4, plates III.

NEWSPAPER BULLETINS.

The newspaper bulletins are but one-page size, and are distributed to some 650 Indiana periodicals and about 50 without the State. They are not sent to other parties and are issued from time to time as circumstances permit or demand:

No. 42, January 14, 1897. The San Jose Scale. (*Aspidiotus perniciosus*). By James Troop, Horticulturist.

No. 43. February 26, 1897. New remedy for potato scab. By J. C. Arthur, Botanist.

No. 44. March 11, 1897. Strawberries: Varieties to plant. By James Troop, Horticulturist.

No. 45. April 27, 1897. Sugar-beet tests in Indiana. By C. S. Plumb, Director.

No. 46. June 19, 1897. Cultivation and thinning of sugar beets. By H. A. Huston, Chemist.

No. 47. July 13, 1897. Hog cholera in Indiana. By A. W. Bitting, Veterinarian.

No. 48. August 2, 1897. Test of varieties of wheat. Winter oats. By W. C. Latta, Agriculturist.

No. 49. October 12, 1897. The San Jose scale in Indiana. By James Troop, Horticulturist.

No. 50. October 27, 1897. The relation of consumers to producers of milk. By C. S. Plumb, Director.

No. 51. November 15, 1897. The sugar beet as food for live stock. By C. S. Plumb, Director.

No. 52. November 22, 1897. Preparation of ground for planting sugar beets. By H. A. Huston, Chemist.

Mailing List. The above periodicals are very widely scattered. The pamphlet bulletin is distributed, as a rule, to the entire mailing list, which now numbers 14,750 names. This list, however, is growing so rapidly that each new edition has to be printed in greater number than the previous ones. The newspaper bulletins are one-page sheets of about 450 words. The following table shows the size of the mailing list at the beginning of each year since 1893:

STATION MAILING LIST.

Number of Names on List.	Jan. 18, 1893.	Jan. 4, 1894.	Jan. 10, 1895.	Jan. 1, 1896.	Jan. 1, 1897.	Jan. 1, 1898.
People in Indiana	5,741	7,131	8,666	9,143	10,590	11,900
Indiana periodicals	635	668	653	625	660	650
People in other states	1,158	1,316	1,606	1,788	1,872	2,000
Periodicals in other states	83	91	86	92	76	80
Foreigners	26	51	61	77	91	105
Foreign periodicals	7	7	7	6	8	8
Total	7,650	9,264	11,079	11,731	13,297	14,750

Live Stock. In connection with the Station equipment I desire to call your attention to the amount of live stock on the farm. The general health of the stock has been most excellent, and there has been a gradual and gratifying increase in numbers and quality during the past few years. Nearly all of the stock is of our own breeding. The following is an inventory about December 31, 1897:

CATTLE.

	Short-horn.	Here-ford.	Jersey.	Holstein-Friesian.	Grades.
Males, yearling or over	0	1	2	1	1
Females, yearling or over	2	3	7	2	1
Calves, males	0	1	1	1	1
Calves, females	0	1	3	0	0
Total, (28)	2	6	13	4	3

SHEEP.

	Rambouillet Merino.	Shropshire.
Ram, one year or older	1	1
Ram, lamb	0	1
Ewes, one year or older	7	5
Ewes, lambs	4	3
Wethers	2	0
Cross bred lambs	0	2
Total, (26)	14	12

SWINE.

	Poland China.	Berkshire.	Chester White.
Males, one year or over................	0	0	1
Males, under one year..................	1	0	2
Females, one year or over..............	1	0	3
Females, under one year	0	1	3
Grades, females........................	0	0	8
Grades, barrows	0	0	4
Total, (24)	2	1	21

Of the above animals, the swine and sheep are beginning to furnish quite useful material for experimental feeding, but the cattle are so uneven in age and so divided up into different breeds that, although very useful for class-room instruction, they do not offer the most desirable material for feeding experiments.

I herewith submit in connection with the above, brief reports of the work of the several Departments of the Station, as transmitted to me by the persons in charge.

Respectfully submitted,

C. S. PLUMB,
Director.

REPORT OF THE CHEMICAL DEPARTMENT.

To C. S. Plumb, Director:

Sir—The following is a summary of the work of the Chemical Department for the year 1897:

SUGAR BEETS.

The interest in the production of sugar beets has been far greater than in any previous year. Many applications for seed were received, and the prospect for an extensive and thorough test of the matter of raising beets seemed promising. It was therefore decided to conduct the tests on such a scale that both the quality of the beets and the kind of work required for the production of commercial beets would be demonstrated. As there seemed to be a probability that beet factories might be erected in the State in the near future, it was thought desirable to urge farmers to become familiar with raising beets under factory conditions, in order that they might be in a better position to consider contracts for raising beets for factory purposes, should such an opportunity arise. The wisdom of this policy became very evident as the season advanced. Before the close of the year beet contracts were presented to farmers in several sections of the State.

Five hundred pounds of beet seed were received from the United States Deparement of Agriculture. Nearly all of this seed was distributed to farmers who engaged to raise from one-fourth to one acre of beets and to follow working directions. The remainder of the seed was distributed to a number of farmers who were willing to raise smaller amounts. Seed was sent to 107 farmers in 23 counties. Most of the work was conducted in northern and central counties, where both soil and climatic conditions seemed more favorable.

The spring was wet and backward, and in some counties seed could not be planted until after June 1st. The severe drouth of August and September found the beets in most cases below normal size for the season. Yet, with these disadvantages very many good results, both in quality and yield, were obtained. In previous years

less than one-third of those to whom seed was sent have reported results or sent samples. This year shows a marked improvement in this respect.

A large number of farmers who had obtained seed from other sources have asked the Station to make analyses of their beets, and in every case this has been done. Over 300 analyses have been made.

The work on the farm of the Experiment Station included, in addition to the testing of a number of commercial varieties, a further study of beets affected with bacterial disease and a set of special tests on very high-grade seed sent out by Dr. H. W. Wiley, Chemist, United States Department of Agriculture.

The results of the work this season have been very gratifying, and in all sections of the State that I have visited I have found that the work is highly appreciated by the people and that the press give the Station the most cordial support in its work on this subject. Three hundred and seven samples from 143 stations in 35 counties have been examined.

FERTILIZER EXPERIMENTS ON CLAY SOILS.

This season these experiments were continued, the land being in wheat. The weather conditions were very unfavorable and the crop in southern Indiana was below the average. The very heavy rains of early spring damaged the plats both by washing and compacting the soil. The crops were harvested and weighed, and, notwithstanding the very unfavorable conditions, enough facts were obtained to serve as an index to the more profitable application of fertilizers on such lands and to point out the methods to be used in further investigations along this line. The two most conspicuous points are the very marked benefits derived from slaked lime which had been harrowed in before planting the corn, which preceded the wheat, and the necessity of drilling the fertilizer with the wheat instead of broadcasting it, if any results comparable with ordinary field practice are to be obtained. The effect of the fertilizers in securing a stand of clover and timothy was very marked. No grass was to be seen on the unfertilized plats.

I think it advisable to continue this work. But the plan must be altered so as to permit the drilling of the fertilizers with the

wheat. This will present some difficulties, unless quite large plats can be used. Yet the large expenditures made for fertilizers and the unscientific and often wasteful methods of purchasing them make it very desirable that actual demonstration of a more rational and economical method should be made..

EXPERIMENTS ON THE PREVENTION OF ROOT ROT.

This season the tests on this subject were tried on a more extensive scale. The results are as promising as last year. The test was applied to 100 trees. Although many good results have been secured in preventing the disease and in checking it on infested trees, the matter is so important that I believe that the work ought to be more fully developed and a fuller study made of the matter before coming to a decision. The extent of the apple interests and the serious loss caused by the disease will more than justify the slight expense involved.

LABORATORY STUDIES OF AVAILABLE PLANT FOOD IN WORN SOILS.

Work on this subject has been continued. The nitrogen contained in the humus extracted from the 20 old series plats that have been under continuous corn crop for 18 years has been determined and comparison data from adjacent land under rotation.

Two samples of Rothamsted soil, which have been under experimental treatment for 50 years, were also obtained. To these only the method for available phosphoric acid could be applied. The results, both absolute and relative, were such as to justify the belief that the method for the determination of available phosphoric acid in worn soils, which was worked out in this laboratory, is one that may be found of considerable value in soil investigations. The method differs radically from any others that have been proposed, in that alkaline solvents are used. Work of this character involves many tedious processes and much careful manipulation. The methods worked out by us have been tested on the principal types of soil with satisfactory results.

CHEESE.

Repeated efforts to find samples of filled cheese on the market have been made, but no such material has been found. The cheese

that seems to have taken the place of it was tested by the pepsin method, but even after many days the material remained undigested. The pepsin solution is the same as that used for the digestion work in food examinations. On either ordinary or filled cheese the casein is liquefied in a few hours and the fat separates and rises to the surface. The cheap cheese that has taken the place of the filled cheese contains very little fat, and the casein seems to be in such a condition as to offer great resistance to digestive ferments.

FEEDING MATERIALS.

A number of feeding materials have been examined. The analyses of those that seem of interest follow:

SUBSTANCES.	LINSEED OIL MEAL. Per cent.	COARSE LINSEED MEAL. Per cent.	LINSEED MEAL. Per cent.
Moisture	7.42	7.42	3.86
Ether extract	2.64	1.46	3.13
Crude protein	39.25	39.50	42.00
Crude fibre	8.53	8.05	9.10
Crude ash	5.38	5.36	5.03
Nitrogen free extract	36.78	38.21	36.88
Total nitrogen	6.28	6.32	6.72
Albuminoid nitrogen	5.96	6.39	6.15
Amide nitrogen	0.32	....	0.57

The three samples are low in oil, showing that they resemble new process meal in this respect. The fat is lower than the average in new process meal and the protein is higher than usual for this product.

COTTON SEED MEAL.

This sample was sent in for examination to see if it was adulterated with hulls:

	Per cent.
Moisture	4.93
Ether extract	9.96
Crude protein	47.75
Crude fibre	4.69
Crude ash	6.43
Nitrogen free extract	26.24
Total nitrogen	7.64
Albuminoid nitrogen	7.45
Amide nitrogen	.19

The results show the meal to be of very good quality, somewhat below the average in fat and above the average in albuminoids.

SILAGE FROM CORN STOVER.

A quantity of corn stover that had been carried over winter was run through the silage cutter and moistened with water in the silo. The fermentation and rise of temperature were such as usually take place in the making of silage. On August 15 samples were drawn and analyses made. An analysis of ordinary corn silage made from sample drawn May 25 is also given. This silage was put up in the fall, using the whole corn plant:

	Stover silage. Per cent.	Ordinary silage. Per cent.
Water	81.01	83.77
Ether extract	0.29	0.45
Crude protein	1.34	2.23
Crude fibre	7.08	4.86
Crude ash	1.50	1.42
Nitrogen free extract	6.22	5.41
Total nitrogen	0.20	0.35
Albuminoid nitrogen	.16	.20
Amide nitrogen	.04	.15

The stock did not eat the silage from the stover as readily as the silage made in the usual way.

PURSLANE.

In September inquiries were received at the Station in regard to the feeding value of Purslane (*Portulaca oleracea*). A sample of the material was collected from the Station grounds on September 22d, and submitted to analysis. The sample contained both blossoms and some matured seeds. The analysis is as follows:

	Per cent.
Water	86.56
Ether extract	0.50
Crude protein	1.81
Crude fibre	2.12
Crude ash	2.23
Nitrogen free extract	6.49
Total nitrogen	0.29
Albuminoid nitrogen	0.23
Amide nitrogen	0.06
Phosphoric acid	0.045
Potash	0.85

The material compares favorably with average samples of corn fodder so far as the protein and ether extract are concerned. Nitrogen free extract is rather lower than in most green fodder, but the amount of water is considerably higher. The ash is higher than any ash that I have seen reported in green feeding stuffs. Owing to the relatively low amounts of fibre and nitrogen free extract, the nutritive ratio is high, being about 5.5. The material has been used to some extent in this State for many years as a food for pigs, and in many localities is highly esteemed. Analysis shows that it is well worth consideration as a feeding material for such animals as will eat it readily.

The material has also a relatively high fertilizing value. The nitrogen per cent. is relatively high compared with other weeds and the amount of potash also relatively large. The amount of phosphoric acid present in the sample is somewhat small as compared with other weeds. The sample, however, grew upon lands to which no phosphate had been applied for a long time, and, as has been frequently noticed in the experiments of the Station, purslane responds very readily to applications of phosphoric acid; it is probable that upon lands containing more phosphoric acid the amount present in the plant would be somewhat higher. The fertilizing value of a ton of the dried material would be about $16.00, reckoning the nitrogen, phosphoric acid and potash at the rates usually applied to commercial fertilizers.

The weed is generally considered a bad one and hard to subdue and, if it can be made to serve either for the purposes of feeding or a green manure, it may become of considerable value to agriculture in the State.

RYE MIDDLINGS.

	Per cent.
Moisture	7.61
Ether extract	2.34
Crude protein	13.62
Crude fibre	3.62
Ash	3.19
Nitrogen free extract	69.62
Total nitrogen	2.18
Albuminoid nitrogen	2.03
Amide nitrogen	0.15

I find but one analysis of this material on record. It differs from the above by having nearly twice as much ether extract and two per cent. less protein.

BUCKWHEAT MIDDLINGS.

This sample was also sent from Logansport.

	Per cent.
Moisture	7.55
Ether extract	9.23
Crude protein	35.87
Crude fibre	4.02
Ash	6.25
Nitrogen free extract	37.08
Total nitrogen	5.74
Albuminoid nitrogen	5.52
Amide nitrogen	0.18

The material has nearly the same ratio of ingredients as old process oil meal, but is somewhat higher in both fat and protein than average oil meal. It is also much richer in these two ingredients than was any of the three samples of buckwheat middlings found in previous records.

IDAHO COFFEE PEA.

This is a species of Astragalus from Prof. C. P. Fox of the Idaho Experiment Station.

	Per cent.
Moisture	6.79
Ether extract	6.56
Crude protein	15.37
Crude fibre	2.47
Ash	3.28
Nitrogen free extract	65.53
Total nitrogen	2.46
Albuminoid nitrogen	2.32
Amide nitrogen	.14

The fat is much higher than is usual for leguminous plants, and the protein lower.

MALT SPROUTS.

Sample sent from Fowler, Ind.

	Per cent.
Moisture	5.55
Ether extract	1.54
Crude protein	27.07
Fibre	12.60
Ash	5.69
Nitrogen free extract	47.55
Total nitrogen	4.33
Albuminoid nitrogen	2.77
Amide nitrogen	1.56

The protein content is slightly above that recorded in previous analyses.

STRAW-BOARD WASTE.

A sample of straw-board waste was examined for fertilizer constituents. The material as received, contained

	Per cent.
Water	69.67
Nitrogen	0.32
Phosphoric acid	0.21
Potash	0.14

The material would have only about one-third of the plant food found in barnyard manure. It would probably decompose slowly in the soil and is not of enough value to pay for hauling any considerable distance. It would probably be used to best advantage on clay land.

A sample of ashes said to be derived mainly from the bark of walnut, oak, etc., was found to contain 1.27 per cent. of potash. This would indicate that the material has been leached, as the amount of potash is less than that contained in ordinary wood ashes.

A sample of waste nitrate of soda from an acid factory was examined. It was practically all sodium sulphate. The nitrogen content was 0.56 per cent.

The sugar content of turnips was determined for the Botanical Department. The sample contained 0.66 sucrose and 4.95 per cent. dextrose.

In connection with a pig-feeding experiment at the farm, analyses of the wheat fed and of the whole grain that passed the pigs were made. With one lot of pigs the wheat was soaked, with the other lot the wheat was fed dry.

The analyses are reduced to water free basis.

SUBSTANCES.	Wheat as fed.	Whole grain in manure.	
		Soaked.	Fed dry.
Ether extract	2.35	2.54	2.55
Crude protein	14.12	13.51	13.75
Crude fibre	3.01	3.49	3.21
Ash	2.30	3.01	2.39
Nitrogen free extract	78.19	77.44	78.10
Starch (by diastase)	61.45	60.75	58.06
Total nitrogen	2.26	2.16	2.20
Albuminoid nitrogen	2.22	2.10	2.16
Amide nitrogen	0.04	0.06	0.04

MARL.

Many beds of marl are found underlying the muck beds of the northern parts of the State. The analysis of a representative sample is here given.

	Per cent.
Moisture	1.00
Insoluble in acid after ignition (sand, etc.)	2.47
Nitrogen	0.53
Silica	0.30
Oxides of iron, aluminum and manganese	1.32
Calcium oxide	44.80
Magnesium oxide	1.64
Potassium oxide	0.20
Carbon dioxide	36.74
Organic matter and undetermined	11.00

The material consists essentially of carbonate of lime and organic matter. The amount of nitrogen present is noteworthy. The condition of the organic matter would be improved by freezing. The material has considerable fertilizing value and would doubtless be of much value as an application to heavy lands. Only a trace of phosphoric acid is present.

Mr. J. M. Barrett has served as Assistant in an exceedingly satisfactory manner.

Very respectfully yours,

H. A. HUSTON,
Chemist.

REPORT OF THE BOTANICAL DEPARTMENT.

To C. S. Plumb, Director:

Sir—The work of the Botanical Department of the Station for the year 1897 has been a continuation of that of the previous year without serious interruption, there having been no change in the personnel of the department or in its policy. At the close of the previous year the rooms of the department were renovated and treated with paint, and an additional room provided, having 300 square feet of floor space, to be especially devoted to laboratory instruction. This improvement has added both to the convenience and the efficiency of the experimental work, by the partial withdrawal of students from the general laboratory, especially for the five months from January to May, inclusive, during which University classes in vegetable physiology, ecology and pathology receive instruction.* A general account of the equipment of the department was given in the report of last year, which remains equally applicable at the present time.

POTATO.

It is a matter for congratulation that the efforts of the department in the study of the potato scab, and especially the attempt to provide a cheap, safe and convenient remedy, have met with the most signal success. Experiments were begun in the greenhouse in the winter of 1895-6 and carried to completion in the field during the following summer, which led to the conclusion that formalin was an effective fungicide against scab, and furthermore, that it met the above-named requirements of cheapness and convenience, and particularly of safety. What had been wanted was a remedy possessing the good qualities of corrosive sublimate, but without its deadly poisonous properties. Such a remedy has been found in formalin.

The results of the trials of 1896 were first published in a newspaper bulletin in February of the present year (1897), in order to give the farming public the benefit of the discovery in time to make

*Much of the botanical instruction provided by Purdue University is given at the laboratories in Science Hall by Professor Stanley Coulter and his associates, especially in general, structural and systematic botany, histology, fermentation, bacteriology, and other special subjects.

it of service in the management of the year's crop. The full report of the experiments, which had been prepared at the close of the previous season, was not printed until June, and in a limited edition. Persons desiring it (Bulletin 65) are expected to make application to the Director of the Station. It will be sent to such persons prepaid and free of charge.

The bulletin on "Formalin for Prevention of Potato Scab" (No. 65) consists of 20 pages and two plates, and gives the history of the subject, the results obtained at the Station, the results obtained by others, some account of the nature of formalin and specific directions for its use. It also discusses the relation of soil moisture to the increase of scab, and details an important method for the estimation of the injury to the crop.

The department carried on no tests of formalin during 1897, but hoped that it would be tried by many potato growers under sufficiently diverse conditions to gauge its value as a serviceable fungicide for general use. All reports so far received from growers agree in commending the remedy as meeting every reasonable requirement and fully affirming the good points claimed for it in the bulletin. Two letters are selected from the correspondence—one from Nebraska and the other from Massachusetts—which not only represent widely different sections of the country, but add some items of practical interest worthy of record.

Mr. B. B. Rice, of Grand Island, Neb., writes, under date of October 27, 1897, that he treated 21 bushels of Early Ohio potatoes. The seed tubers were "large, quite free from scab, having been selected from the scabby crop of last year." He purchased a one-pound bottle of formalin ($1.25). Two barrels were used, and into each was put (by guess) 15 gallons of water and one-half the formalin. A bushel of uncut potatoes contained in a sack was dropped into each barrel, and after remaining a time, another bushel was put in, the same solution being used over and over until all were treated. The course of treatment was as follows:

One bushel in each barrel 3 times for 2 hours	6 bushels
One bushel in each barrel 2 times for 2¼ hours	4 bushels
One bushel in each barrel 2 times for 2½ hours	4 bushels
One bushel in each barrel 2 times for 2¾ hours	4 bushels
Three-fourths bushel in each barrel 2 times for 3 hours	3 bushels
Total	21 bushels

He goes on to say (and this is a specially valuable contribution to the subject): "I could detect no difference in the amount of scab in the crop from seed treated first or last." He says, further: "I think now that the seed, although quite clean, should have been washed before it was placed in the solution, but I did not know it at the time the treatment was given. The 21 bushels were planted on four acres. One-third the field was well cared for; there the tubers were quite free of scab. The rest was very weedy and the potatoes a little more scabby. Yet on the whole the crop was not more than one-third as scabby as it was last year. The average yield was over 80 bushels per acre. I think your remedy is valuable and that it has benefited me, for the neighbor from whom I bought my seed a year ago did not doctor his potatoes last spring, and his crop this fall is very scabby—three times as bad as mine. Both fields of potatoes were planted in fresh soil—land not previously used for potatoes."

The other letter from which I wish to quote was received from Mr. Frank H. Goodhue, of North Andover, Mass., dated December 18, 1897. He writes: "The land I used for the experiment, about three-fourths of an acre, had been in mowing for 13 consecutive years. I broke the sod about nine inches deep, then harrowed thoroughly, furrowed three feet apart and put seed about one foot apart in the hills.

"I used 800 pounds Stockbridge potato fertilizer and 500 pounds Standard potato fertilizer, but used no stable manure. I put a large handful of fertilizer in each hill, mixed it thoroughly with the soil, then dropped the seed, covering it with about two inches of soil, scattered another handful of fertilizer over it, and finished off with some more soil. In order that the fertilizer might not cause the tubers to vary, the same kind was used on treated and untreated seed of each variety.

"The land was nearly level, only a slight rise on the west side; soil moist, but not wet. As far as moisture was concerned, the soil was alike on both treated and untreated seed. There was not a tree or building near the field to interfere.

"I planted four bushels each of Somerset and Rose Standish and also a few potatoes of Early Harvest and Early Fortune, and also some of Dandy and Old Merino, one-half of each variety being treated with formalin. The smaller lots were subjected only two

hours to formalin, but the Somerset and Rose Standish were treated three hours. All of the seed was nearly free from scab. In order to be as accurate as possible, I put only three rows of untreated seed between the rows of treated seed.

"The seed was treated, then dried and planted about a week after treatment. Being very busy, I did not empty the formalin for eight days after using, and on doing so I found two tubers of the Somerset variety in the bottom of the cask. I planted them along with the Rose Standish that were not treated, making two hills of them, so that I would know them at harvest time. When we came to them I dug them myself. They were large, smooth and the cleanest potatoes I have ever dug from the soil.

"All the treated seed produced clean, smooth and handsome tubers, with not a rotten one among them, while the untreated were rather inferior in size, with many tubers considerably scabbed, say one-third of the surface, and about 3 per cent. were rotten.

"I think, with eight ounces of formalin to 15 gallons of water, that four hours' treatment are better than two hours. I am also inclined to believe the remedy is to some extent a preventive for rot."

Both of these reports indicate the important character of this remedy and the ease of its application. As shown by Mr. Goodhue, the length of time the seed tubers are kept in the solution does not noticeably affect their growth, especially if they have not sprouted too much, and a longer immersion kills the germs of the scab disease more completely. It is probable that the repeated use of the same solution could not, as a rule, be safely carried so far as practiced by Mr. Rice, but a half dozen times might still give good results, if the tubers were free from dirt and the periods of immersion were sufficiently prolonged. The report of Mr. Goodhue is especially to be commended for the careful way in which the treated and untreated material were subjected to uniform conditions. It will be a most important point gained when cultivators generally learn to try new remedies and methods of all kinds with a control for comparison, as in this case.

LETTUCE.

Several crops of lettuce have been grown in the greenhouse of the department during the last two years, but the most important part of the work reached completion in 1897. The results have

been embodied in a bulletin of 20 pages and two plates, prepared by the Assistant Botanist, Mr. William Stuart. This bulletin has been sent to those thought to be interested in the subject. It can be obtained by others upon application to the Director. A brief statement of the main facts, unaccompanied by tables, has been prepared and printed by the Station in a bulletin bearing date of October, 1897.

The results obtained embrace some important items for the cultivation of indoor lettuce. By the use of commercial fertilizers the yield of the benches was increased more than three and a half times, when properly combined and applied; but with injudicious use their application decreased the yield. A moderately thick planting was found, contrary to expectation, to produce a heavier crop per square foot of bench than thinner planting. The use of flower pots to secure a ball of earth around the roots when marketed, and also for convenience in handling, was found to invariably lessen the yield. A method of obtaining the advantages of the pot with only the slightest check to growth is recommended in the bulletin, based upon the result of the experiments. The crops obtained by methods considered commendable were of the highest market value in both amount and quality.

CORN.

Observations and studies of corn smut have been continued during the year. The inoculation of young plants in second leaf with formation of smut pustules was successfully accomplished during October in the greenhouse by spraying with germinating spores. All the results and facts obtained will eventually be brought together in a bulletin.

BEET.

Further researches into the nature of the peculiar sugar-destroying disease of the sugar beet, some account of which has already been published in Bulletin No. 39 (April, 1893), and there ascribed to a specific kind of parasitic bacteria, have been prosecuted, most of the work being done by Miss Clara Cunningham as a part of her University studies. The bacterial nature of the disease, a point which has been called in question, has been confirmed, and many

details of the life history of the parasite have been worked out. Excellent photographs have been secured, showing clearly the characteristic appearance of diseased beets, which will be used to illustrate the next contribution to the subject.

ROSE.

The use of different commercial fertilizers in growing the rose for cut flowers has been continued from last year. The same plants that were used last year, having been wintered in a cold pit, were used again without repotting. Most of the cans received an additional amount of the same fertilizers used the preceding season, a few cans being reserved, however, for special treatment. The results of the season confirm in the main those of last year.

In order to test in the open field the results obtained in the vegetation house, a piece of ground was planted with 14 varieties of hardy and semi-hardy roses. They were from two-and-a-half-inch pots, twelve of each variety. Nothing of importance was learned the present season, however, as the plants did not become sufficiently well established to respond noticeably to the presence of fertilizers.

This set of experiments is especially under the charge of the Assistant Botanist.

CINERARIA.

The plants of this attractive flower, which had been brought into bloom in December, 1896, continued to fill the greenhouse to its full capacity through January, February, March and April with a rich and brilliant display of flowers. Many of the plants bore more than 300 flowers each, and as specimen plants or in mass were universally admired. About 30 ladies of the city were asked to coöperate with the Station in testing the adaptability of the plants to decorative purposes under ordinary household conditions. They received plants and cared for them as they thought best until no longer decorative, reporting upon the frequency of watering, amount applied, temperature of the rooms, extent of exposure to sunlight, time when the first flowers failed and time when the plant became unattractive. The trials resulted most satisfactorily, and,

taken altogether, much data has been accumulated upon the method of handling the plant and its adaptability to household decoration, which it is hoped may be early embodied in a bulletin.

FOOD OF PLANTS.

Of all the problems in the physiology of plants, probably none so directly bears upon the methods and profits of intensive farming and high cultivation generally as the application to the soil of barnyard and commercial fertilizers for the purpose of supplying food for the growing crop. Great advance has been made since the days of Liebig, the great promoter of high-grade husbandry, in the profitable use of fertilizers and in a knowledge of the requirements of different crops, and yet the practice remains largely empirical.

An exact knowledge of the kinds of food required by each kind of plant, of the method of its assimilation and of the apportionment of it within the plant to the building up of the different organs, has been exceedingly difficult to acquire. From Roman days, when agriculture was held in such high esteem that it was considered a worthy subject for the pen of the greatest poets, until the present time, little of a fundamental character has been added to our knowledge of the subject by the open-field method. Field experiments properly follow, but cannot take precedence, in providing the initial facts upon which rational husbandry should find a sure foundation. A great impetus was given to the elementary study, when, in 1860, the modern method of water cultures was introduced, by which, among other things, the now well-known fact that the carbon of the plant is obtained from the air and not from the soil was first definitely established. Since then cultures in water, sand and artificial earths and in restricted amounts of soil, kept under conditions controlled by the experimenter, have yielded the most valuable additions to our knowledge.

With a view of promoting a better understanding of some of the questions connected with the food and food supply of plants, the department has carried on studies in pot and bench cultures since the erection of the vegetation house, in 1893. Oats, wheat, corn, potatoes, buckwheat, roses, lettuce and certain weeds have been used in the experiments. Some of the data, discussed from the commercial side, was recently presented in the lettuce bulletin,

referred to above, but the bulk of the results yet remain unpublished. It is proposed to continue these studies, with the hope that they may add some facts of importance to exact knowledge, and in particular, furnish data for improved and more economical ways of increasing yield by means of fertilizers.

SIZE OF SEED.

Experiments have been instituted from time to time, and the results partly published, which have established beyond doubt that the larger seeds of any particular kind of plant give a larger crop than the smaller seeds, both being grown under the same conditions. The experiments are now being continued in a somewhat modified form to ascertain how far the increase can be expected to extend, by selecting the largest seeds from each successive generation. Peas and beans are used, an account being kept of the size of the seeds sown each time, and of the size of the resulting plant, as well as of the number and size of the resulting seeds. It is, in fact, an attempt to ascertain the law of increase in size when brought about solely by the selection of the largest seeds through a series of generation.

SUB-WATERING FOR GREENHOUSES.

Of the various factors influencing the growth of plants, none is of greater moment than the control of the water supply. It has been until recently almost an axiom in culture under glass that an atmosphere heavily charged with moisture was a prime essential to success. To secure this condition excessive watering and sprinkling of the surface was resorted to. The plants being grown in shallow benches or in pots often suffered for moisture in the soil about the roots when the surface soil and the atmosphere were excessively moist.

Most crops forced under glass, especially those belonging naturally to temperate climates, such as tomatoes, lettuce, radish, cauliflower, carnations, roses, chrysanthemums, etc., thrive best with a moderately moist and well-aerated soil and rather dry atmosphere. The last condition is especially needed to promote a rapid movement of water through the plant, by which the food materials taken

from the soil are transported to the upper parts and made available for growth. In some cases the continued health of the plants depends upon the strength of this transpiration stream.

This method of sub-watering supplies moisture readily to the part of the soil where it is most needed; it keeps the soil friable and well aerated; it prevents the packing of the surface soil and retards the accumulation of weeds and slime; it promotes a drier atmosphere, especially in contact with the plants, and removes much of the danger of invasion by molds, rots and other fungous diseases by permitting the surface of the foliage to be kept dry, and in many ways it brings about cultural conditions better than those obtained by the old methods.

The crops grown with this system of watering are larger and of better quality than usually secured, and it is believed that the results of our trials, especially during 1897, warrant its recommendation for commercial houses, although the first cost is considerable (13 cents per square foot in the trial bench at the Station). The system has been explained, with illustrations, in the bulletin on indoor lettuce (No. 66), previously referred to.

OUTSIDE STORAGE.

For several years the department was without suitable means of carrying tubers, bulbs and dormant plants through the winter. In the fall of 1896 an outside storage pit was constructed that has met the demands so fully that it is worthy of brief mention. There is nothing novel about the method, but its cheapness and efficiency are probably not generally recognized.

The pit consists of a cellar nine by fifteen feet, two-thirds sunken below the general surface of the ground, with five hotbed sashes forming the north slope of the roof, and the rest of the roof and the sides banked with earth and layers of straw. A bulkhead entrance with inner door and extra banking of straw in the coldest weather kept the pit from freezing during the winter of 1896-7. The bench was formed by leaving a ledge of earth, and the roof and side supports were made from the roughest material. The total cost of the structure was very small.

Perle des Jardin and Kaiserin Augusta Victoria roses, altogether over 100 pots, were placed in the pit November 25 and were

taken out April 1, every plant in excellent condition, many of them still retaining much of their foliage. A few potatoes were also stored in the pit, and were kept in perfect condition. It is again being used to its full capacity for the winter season of 1897-8.

This is a cheap and efficient means of winter storage, and its possibilities deserve to be kept in mind. The department could economically use a much larger pit than the present one, and the purposes to which it is put might profitably be much extended.

Respectfully submitted,

J. C. ARTHUR,
Botanist.

REPORT OF THE HORTICULTURAL DEPARTMENT.

To C. S. Plumb, Director:

Sir—The following is a summary of the work done during the past year in the Horticultural Department:

Owing to the absence of a greenhouse, all of the experimental work of this department has of necessity been carried on in the orchard and garden. During the past summer a greenhouse was built for the purpose of carrying on experiments in forcing fruits and vegetables. This house is 50 feet in length and 18 feet wide, with a span roof and glass partition in the center, and is so piped as to enable us to preserve a high temperature in one room and a low temperature in the other. In the one room will be grown such plants as tomatoes and cucumbers, while the other will be used as a combination insectary and lettuce-forcing house. Adjoining this

Fig. 1. INSIDE VIEW OF GREENHOUSE.

house is a work room 12 by 18 feet, built of brick and fitted up with bins for soil and benches for the use of students in horticulture. The illustrations in the frontispiece and Fig. 1 of this report show an external and internal view of the house.

TESTING VARIETIES OF FRUIT.

The work of testing varieties, while not of the highest importance, is made necessary by the fact of so many varieties that are being constantly put upon the market. These varieties are sent to us for testing as to their fitness for a place among the older varieties; and in order to arrive at an intelligent conclusion, a considerable amount of time and space must be given to the work. During the past season there have been tested 86 varieties of strawberries, 28 varieties of raspberries and 16 varieties of blackberries, besides over 50 varieties of grapes and a number of varieties of currants and gooseberries. These have all been, or soon will be, reported upon through bulletins from this department.

The process of top working the Russian varieties of apples with our native varieties is progressing. A large number of scions were obtained by exchange from the Horticulturist of the Experiment Station at Pullman, Wash., and grafted into these trees last spring.

CLOSE ROOT PRUNING.

The experiment begun last year of close-root pruning trees at the time of planting has been continued. Last year the trees were pruned in the spring and allowed to grow but a single season, with varying results, according to the varieties. In the fall of 1896 a row of two-year-old Wealthy apple trees was planted, each alternate tree being pruned, so that only about two inches of root remained, the balance being left in the natural condition. These will be left to grow two seasons before taking them up.

WHOLE VS. PIECE-ROOT GRAFTING.

In the spring of 1897 the Department of Agriculture sent us for testing nine varieties of Hungarian apple trees, three trees of each

variety, grafted on whole roots, top cut and bottom cut. The varieties are as follows: Bottysui, Cillogos, Kechskemet, Magyar, Micholyfi, Noble Sovar, Nyaripiros, SeKula and Summer Wafer. These trees were planted in the orchard, where they are to remain for the purpose of studying the effect of all the various modes of grafting.

TESTING THE INFLUENCE OF CLIMATE ON FOREST TREE SEEDLINGS.

In the fall of 1896 this department received a large number of packages of forest tree seeds, representing 21 different States and Territories, from the Division of Forestry, Department of Agriculture, Washington, D. C., with a request that these seeds be planted and careful notes taken, for the purpose of ascertaining the effect of climate on the seedlings thus produced. These seeds were planted last spring and a very good stand secured. The report for the first year has been filed with the Chief of the Division of Forestry. This very interesting experiment will be continued and a large number of additional varieties added next year, seeds of which have already been obtained.

NEW VARIETIES OF POTATOES AND METHODS OF CUTTING.

The following new varieties of potatoes were received during the spring for testing. They were planted in two-eye pieces and given ordinary field cultivation. Before the tubers were half grown, however, the drouth came on, and, as a result, the yield was cut down in some cases 50 per cent. or more, as shown by the number of small tubers at the time of harvest. Following is the yield of large and small tubers:

Variety.	Bushels Per Acre. Large.	Bushels Per Acre. Small.
Livingston	87.73	42.35
Uncle Sam	90.37	38.66
Early Michigan	136.12	58.23
Sir Walter Raleigh	222.64	
Bovee	212.96	38.72
Early Trumble	90.35	77.44
Andes	58.00	54.21
Country Gentleman	90.00	59.00
Early Thoroughbred (Maule's)	73.35	60.50

VARIETY.	How Cut. No. Eyes to a Hill.	Bushels Per Acre. Large.	Bushels Per Acre. Small.
Beauty of Hebron.........	Four eyes in one piece........	94.00	74.00
Beauty of Hebron.........	Four eyes in four pieces	90.30	86.80
Beauty of Hebron.........	Two eyes in one piece.........	90.60	53.00
Beauty of Hebron.........	Two eyes in two pieces	106.00	45.30
Beauty of Hebron.........	One eye in one piece..........	100.00	30.00
Beauty of Hebron.........	Seed end	48.40	40.00
Beauty of Hebron.........	Small, whole	96.40	75.60
Beauty of Hebron.........	Cut crosswise, upper half, seed end up....................	75.60	83.00
Beauty of Hebron.........	Cut crosswise, lower half, stem end up..................	81.60	95.30
Beauty of Hebron. Seed from Pennsylvania	Large, whole on a stem end...	71.08	104.33
Second crop seed from Kentucky.................	Same as above...............	146.70	87.72

It will be seen that in a few cases the yield of small, unmarketable potatoes was actually larger than that of the marketable size, which was due, as has been said, to the dry weather. Another interesting fact is shown; that is, the lower half of the tuber, including the stem end, gave a larger yield of marketable tubers than the "seed end." Also, that the "second-crop seed" from Kentucky yielded 75 bushels per acre more of large tubers than the same variety, first crop, grown in Pennsylvania. This is partially due to the fact that the second-crop seed is from 10 to 12 days earlier than the other, so that more of the tubers were matured before the drouth commenced.

TOMATOES.

A large number of varieties of tomatoes were planted with a view of testing the relative value of each for canning purposes, but owing to the excessively dry weather, the experiment was abandoned.

LIST OF SEEDS ,PLANTS, INSECTICIDES, ETC., RECEIVED FOR TESTING.

Name of Plants.	*From Whom Received.*
Package Puget Sound Snowball cauliflower	H. A. Marsh, Fidalgo, Wash.
Package Early Erfurt cauliflower	H. A. Marsh, Fidalgo, Wash.
Clark blackberry	M. Crawford, Cuyahoga Falls, Ohio.
New winter radish No. 98	
Danish Ball Head cabbage	
Mayflower tomato	
Leafless radish	
Australian brown onion	
New lettuce from Italy	
Golden Eagle muskmelon	
Asparagus pea	
Italian ice lettuce	W. Atlee Burpee, Philadelphia, Pa.
Kleckley Sweets watermelon	
Long yellow stump-rooted carrot	
Rose ribbed self-blanching celery	
New Pink Prizetaker onion	
Fordhook pickling cucumber	
Carter's Daisy pea	
New stringless green pod bush bean	
Early Winningstadt cabbage	John A. King, Coggshall, Essex, England.
Early York cabbage	John A. King, Coggshall, Essex, England.
Dwarf white celery	
Philadelphia early turnip	
Beauty of the Parterre parsley	Dept. of Agri., Washington, D. C.
Buckeye tomato	
Seedlings of Chinese persimmons	
Saunders' Early blackberry	John Saunders, Oakland City, Ind.
Early Red Globe onion	G. G. Silbertson, W. Mitchell, Ia.
Early Trumble potato	E. Tully, Penza, Ohio.
The Andes potato	H. C. Marsh, Muncie, Ind.
Sir Walter Raleigh potato	Peter Henderson, New York.
Bovee potato	Peter Henderson, New York.
Ridgeway strawberry	M. H. Ridgeway, Wabash, Ind.
Seedling raspberry No. 10	M. H. Ridgeway, Wabash, Ind.
Nine varieties Hungarian apples	Dept. of Agri., Washington, D. C.
The Hoosier strawberry	Ran Beuoy, Matthews, Ind.
"96" strawberry	Ran Beuoy, Matthews, Ind.
Moorhead raspberry	H. Mahan, Terre Haute, Ind.
The Stahelin strawberry	F. C. Stahelin, Bridgeman, Mich.
The Centennial apple	B. F. Albaugh, Covington, Ohio.
Several samples of insecticides and fungicides	Powell Fertilizer and Chemical Co., Baltimore, Md.
1-pound can of Goodell's gray mineral ash	National Mining and Milling Co., Baltimore, Md.
3-gallon can of Roseleaf tobacco insecticide	The Spirit Cured Tobacco Co., Louisville, Ky.
Strawberry Runner cutter	The Carter Mfg. Co. Jackson, Mich.

The seeds were all planted, but owing to the exceedingly dry weather, the test was not considered a satisfactory one, and the results are not published. The plants will be reported upon next year. The insecticides and fungicides were all tested with good results. The rose-leaf tobacco extract is especially adapted for greenhouse work as a preventive of aphis and red spider, and as such it has proven very satisfactory.

Respectfully submitted,

JAMES TROOP,
Horticulturist.

REPORT OF THE VETERINARY DEPARTMENT.

To C. S. Plumb, Director:

Sir—Since making the last annual report no changes have been made in the apartments of the Veterinary Department nor apparatus added. The equipment has been ample for the work under consideration. The work has been directed along the following lines:

1. A study of the water supply for live stock in the State.
2. A continuation of the study of hog cholera.
3. A continuation of the study of tuberculosis.
4. A study of the treatment of contagious abortion among cattle.
5. A study of the fecundity of swine.
6. A study of the relative frequency of occurrence and distribution of diseases of stock in the State.
7. A study of sheep dips.
8. A study of the embryology, anatomy and physiology of the mammary gland.

WATER.

A study of the water supply for live stock in this State was conducted to determine the quality of water being furnished to stock and to determine the relationship, if any existed, between the water supply and disease. The work was divided into three parts—a bacterial study of surface and deep well waters, a field survey of the kind of water being supplied and the diseases present among stock, and a statistical study of the death rate among animals in the townships bordering upon the streams and those removed a few miles from streams. A summarized statement of this work is now in your hands as a bulletin.

TUBERCULOSIS.

The work upon tuberculosis has been largely field work, making diagnosis by the tuberculin tests and in assisting cities in making dairy inspections. The work has not been different from that done at other stations, but has been conducted with the view of obtaining data upon our local conditions. Since the Station made the first test in the State, nearly 2,000 cattle have been tested. A part of these have been tested by other veterinarians, who have furnished us their reports. At present the city of Indianapolis is testing all dairies when application is made for a health certificate. This will probably have the effect of adding 1,000 more tests to our records. The importance of the test as a means of diagnosing tuberculosis is just beginning to be felt in this State, and the present indications are that at least four more cities will inaugurate the tuberculin test as a part of their dairy inspection within the coming year.

No experiments have been conducted to study the means of infection or the danger arising from the use of the milk or flesh of affected animals. The experiments at other places have been much more thorough than could be conducted here with the present facilities. The recent claims made for the curative properties of oxy-tuberculin would warrant a trial treatment upon some cattle and should be undertaken as soon as possible.

THE FECUNDITY OF SWINE.

There is a very prevalent impression among farmers that it is unprofitable to breed pure-bred swine for breeding purposes, as they are supposed to be less prolific than the ordinary stock. The impression is general not only among farmers, but also among agricultural writers, and is sometimes hinted at by station workers. The statement is frequently made that the pure-bred hogs are less prolific than they were a few years ago, and that it is only a question of time until they will cease breeding in sufficient numbers to be profitable.

It is not the object of this inquiry to discuss influences which affect fecundity, but to make an inquiry into the number of pigs farrowed in the first 200 litters recorded in the various herd registers and in the last 200 litters, and make comparisons. At the same time this work was being done an inquiry was also made as to the number raised and the sex.

In compiling the data, 100 different litters were taken, from which sows were recorded, and 100 from which boars were recorded. The dates of farrowing for the first 200 litters vary through several years, while of those of the last 200 litters nearly all occurred in 1896. Owing to the imperfect method of recording the pedigrees of some registry associations, complete data could not be obtained upon all points desired or upon the full number. The following tables show the number of litters and size of litter, the total number farrowed in each litter and the gain or loss of the last litters over the first litters recorded. In like manner it shows the number raised:

BERKSHIRES.

(National Herd Register.)

Number of Pigs in Litter.	Number of Litters Farrowed. First 200 Litters.	Last 200 Litters.	Total 400 Litters.	Number of Pigs Raised. First 200 Litters.	Last 200 Litters.	Total 400 Litters.
1	0	0	0	0	0	0
2	1	0	1	3	2	5
3	1	3	4	7	6	13
4	7	4	11	12	15	27
5	10	13	23	19	25	44
6	12	23	35	20	26	46
7	34	41	75	44	49	93
8	48	35	83	38	30	68
9	35	30	65	34	28	62
10	25	23	48	15	9	24
11	14	12	26	5	3	8
12	8	11	19	2	5	7
13	2	4	6	2	1	3
14	0	1	1	0	1	1
15	2	0	2	0	0	0
16	1	0	1	0	0	0
Total.............	1,664	1,625	3,289	1,463	1,405	2,868
Average	8.32	8.13	8.22	7.37	7.03	7.15
Decrease in last litters over first litters	....	—.19	....	....	—.34	....

POLAND CHINA.

(Ohio Record.)

No. of Pigs in Litter.	No. of Litters Farrowed. 1st 200 Litters.	Last 200 Litters.	Total 400 Litters.	No. of Pigs Raised. Last 200 Litters.
1....	2	0	2	....
2....	3	1	4	2
3....	5	1	6	8
4....	11	10	21	13
5....	11	19	30	22
6....	26	36	62	30
7....	47	40	87	45
8....	42	31	74	36
9....	29	26	56	28
10....	12	16	28	13
11....	8	10	18	2
12....	2	4	6	1
13....	0	5	5	0
14....	1	0	1	0
15....	0	0	0	0
16....	1	0	1	0
Total	1,468	1,510	2,978	1,247
Av. per Litter.	7.34	7.65	7.45	6.24
Inc. last 200 Litters.	.....	+.31	.....	....

POLAND CHINA.

(Standard Record.)

No. of Pigs in Litter.	No. of Litters Farrowed. 1st 200 Litters.	Last 200 Litters.	Total 400 Litters.	No. of Pigs Raised. Last 200 Litters.
1...	0	0	0	2
2...	1	1	2	8
3...	3	6	9	13
4...	11	8	19	22
5...	21	14	35	30
6...	34	37	71	45
7...	45	36	81	36
8...	36	44	80	28
9...	30	27	57	13
10...	10	16	26	2
11...	4	9	13	1
12...	2	1	3	0
13...	1	1	2	0
14...	1	0	1	0
15...	0	0	0	0
16...	1	0	1	0
Total	1,448	1,475	2,923	1,189
Av. per Litter.	7.24	7.38	7.31	5.94
Inc. last 200 Litters.	.....	+.14	.....	....

POLAND CHINA.

(Central Record.)

No. of Pigs in Litter.	No. of Litters Farrowed. 1st 86 Litters.	Last 200 Litters.	Total 286 Litters.	No. of Pigs Raised. Last 200 Litters.
1..	0	0	0	2
2...	0	1	1	4
3...	1	4	5	13
4...	3	6	9	16
5...	10	30	40	37
6...	6	21	27	35
7...	17	34	51	39
8...	9	49	58	32
9..	20	27	47	12
10...	6	17	23	9
11...	6	7	13	0
12...	1	3	4	1
13...	4	0	4	0
14...	2	0	2	0
15...	0	1	1	0
16...	1	0	1	0
Total	706	1,485	2,191	1,247
Av. per Litter.	8.20	7.41	7.60	6.24
Dec. last 200 Litters.	.....	—.79	.....	....

CHESTER WHITE.

(Todd's Record.)

No. of Pigs in Litter.	No. of Litters Farrowed. First and Last 100 Litters.	No. of Pigs Raised. First and Last 100 Litters.
1	1	2
2	0	2
3	3	6
4	3	7
5	12	21
6	16	20
7	25	41
8	29	33
9	36	37
10	37	22
11	14	6
12	10	1
13	8	0
14	0	2
15	5	0
16	0	0
17	1	0
Total	1,749	1,487
Av. per litter	8.74	7.43

CHESTER WHITE.

(Standard Record.)

No. of Pigs in Litter.	No. of Litters Farrowed.			No. of Pigs Raised.		
	First 200 Litters.	Last 200 Litters.	Total 400 Litters.	First 200 Litters.	Last 200 Litters.	Total 400 Litters.
1	0	0	0	0	0	0
2	1	0	1	2	2	4
3	0	2	2	1	8	9
4	3	2	5	6	13	19
5	12	12	24	18	22	40
6	10	13	23	21	30	51
7	24	17	41	31	45	76
8	34	42	76	54	36	90
9	36	31	67	29	28	57
10	37	27	64	28	13	41
11	19	18	37	6	2	8
12	6	15	21	2	1	3
13	7	9	16	1	0	1
14	5	5	10	0	0	0
15	1	3	4	0	0	0
16	1	3	2	0	0	0
17	2	0	1	0	0	0
18	1	0	1	0	0	0
19	1	0	1	0	0	0
Total	1,812	1,814	3,626	1,550	1,518	3,068
Av. per litter	9.06	9.07	9.06	7.75	7.59	7.67
Increase or decrease in last 200 litters	......	+.01	......	......	—.16	......

SUMMARY.

No. of Pigs in Litter.	Total Number of Litters Farrowed.				Number of Pigs Raised.			
	Berkshire. 400 Litters.	Poland China. 1,086 Litters.	Chester White. 600 Litters.	Total. 2,083 Litters.	Berkshire. 400 Litters.	Poland China. 600 Litters.	Chester White. 600 Litters.	Total. 1,600 Litters.
1	0	2	1	3	0	4	6	10
2	1	7	1	9	5	15	11	31
3	4	20	5	29	13	37	25	75
4	11	49	8	68	27	61	47	135
5	23	105	36	164	44	100	76	220
6	35	160	39	234	46	127	96	269
7	75	219	67	361	93	111	131	335
8	83	212	105	400	68	82	90	240
9	65	160	103	328	62	39	78	179
10	48	77	101	226	24	20	30	74
11	26	44	51	121	8	3	9	20
12	19	13	31	63	7	1	2	10
13	6	11	24	51	3	0	0	3
14	1	4	10	15	1	0	2	3
15	2	1	9	12	0	0	0	0
16	1	3	4	8	0	0	0	0
17	0	0	3	3	0	0	0	0
18	0	0	1	1	0	0	0	0
19	0	0	1	1	0	0	0	0
Total	3,289	8,092	5,375	16,756	2,868	3,683	4,555	11,106
Average	8.22	7.45	8.96	8.04	7.17	6.14	7.62	6.94

A study of the tables show that, while there seems to be a reduction in the number of very large litters, the total number farrowed is about the same as shown by the first records.

It is not the intent to compare breeds, but to compare the earliest and latest records of litters to determine whether there has been a real gain or loss in the fecundity of the breed.

The number of boars and sows raised was as follows:

Berkshire, 400 litters, 2,866 pigs, 1,498 boars, 1,368 sows.

Poland China, 1,000 litters, 6,542 pigs, 3,228 boars, 3,314 sows.

Chester White, 600 litters, 4,555 pigs, 2,236 bores, 2,319 sows.

In a total of 3,693 pigs farrowed and all raised, there were 1,786 boars and 1,907 sows.

EXPERIMENTS IN DIPPING SHEEP FOR TICKS.

During the summer a number of experiments were made in the field and laboratory upon sheep dips for ticks. The tick unquestionably causes considerable loss to the sheep industry in the State, and the practice of dipping is becoming common. The dips recommended for the destruction of ticks are usually those that have been found to be effectual in destroying the scab parasite. While the scab dips are effectual, it is desirable to use the one least injurious to wool and sheep and most easily applied. The principal dips tried last summer were the new dips that resemble creolin, but which are much cheaper. They were Chloro-naptholeum, Zennoleum, Potter's Perfection Dip and Daytholeum. Experiments were made by dipping sheep in solutions of different strength and by taking live ticks and dipping them in the solution at the laboratory to determine the strength that would prove fatal. Samples of the different dips were received from the manufacturers and purchase made in the open market. The experiments were all conducted with material purchased in the market. The results of the experiments showed that all of these dips were effectual when used at a solution of one part to 100 of water; that they mixed readily with warm or cold water; that they maintained their strength throughout the dipping; that they were not injurious to the sheep or wool; were easily applied and economical. The details of this work are to be published elsewhere by the Station and in the Proceedings of the Indiana Wool Growers' Association.

THE MAMMARY GLAND.

The study of the mammary gland is not yet completed, but will probably be within the next few months.

DISEASES OF LIVE STOCK.

In nearly all works upon diseases of live stock more or less importance is attached to the influence of season and location upon the occurrence of certain diseases. Some diseases, as pneumonia and pleurisy, are said to occur more often in the spring of the year, due to sudden changes of temperature, cold rains, etc., than at other seasons. Other diseases, like cerebro-spinal-meningitis (staggers), are said to occur in the fall, due to the condition of the pasture or development of certain fungi at that period. How far these statements are true we are unable to decide, as the statistical records published are too few to warrant drawing conclusions. It has seemed desirable to have more observations upon these points, and for two years we have endeavored to collect the necessary data from the practicing veterinarians. Blanks were sent out to all the veterinarians, asking for a monthly report upon the diseases occurring in their practice. The results for the year 1896 were unsatisfactory, and no reports were received after the eighth month. In 1897 a different plan was pursued—return postal cards, with printed blanks, were sent out each month. The results are not altogether satisfactory, but they do give a basis for comparison upon 15 reports.

There are about 100 qualified veterinarians in the State, and about 40 sent in reports a part of the time, and fifteen for each month. Those giving full reports are located at Alexandria, Anderson, Columbus, Connersville, Evansville, Fort Wayne, Greensburg, Indianapolis, Lafayette, Muncie, Portland, Terre Haute, Tipton, Vincennes and Winchester. Two tables are presented, one showing the total number of cases reported each month and one giving the total number of cases reported from the fifteen cities each month. These tables are comparable:

TABLE I.

Summary of All Cases Reported Each Month by Fifteen Veterinarians in Indiana.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Lameness	335	231	163	165	170	217	144	257	160	108	191	146	[illegible]
Fistulae	66	24	16	24	26	49	35	37	28	36	23	15	[illegible]
Bursatte						7	11	5	1	1			
Cerebro spinal meningitis	7	2	5	5	3	4	1	4	5	2	3	3	[illegible]
Parturient apoplexy	45	32	30	37	37	63	28	20	30	29	21	14	[illegible]
Periodic ophthalmia	30	22	19	23	23	32	23	28	25	14	21	13	[illegible]
Pleurisy	29	16	16	16	23	9	5	18	24	[illegible]			[illegible]
Pneumonia	81	32	24	26	17	19	16	29	27	[illegible]	[illegible]	26	[illegible]
Laminitis	41	18	22	22	28	40	39	43	34	[illegible]	21	9	[illegible]
Enteritis	20	10	12	6	14	8	11	27	16	11	10	9	[illegible]
Gastritis	15	6	13	9	17	21	19	13	21	30	23	22	[illegible]
Colic	97	140	154	175	145	187	126	163	170	156	141	125	[illegible]
Azoturia	83	89	67	89	51	19	13	13	13	22	19	28	[illegible]
Canine distemper	50	73	43	33	12	27	15	20	24	26	26	23	[illegible]
Specific ophthalmia (of cattle)	16	10	2				1	7					36
Sporadic aphthae	1	11	1		2	1			4		1	1	22
Tetanus	34	10	8	11	14	1	4		12	19	70	6	149
Tuberculosis	8	5	4	3	8						25		48
Influenza	423	220	196	141	96	142	103	140	150	147	188	162	2110
Rabies	2							2	4	2			10
Glanders	5					1	2						8
Actinomycosis	19	8	5	7	9	5	6	2	10	9	8	1	89

TABLE II.

Summary of All Cases of Disease Reported Each Month in Indiana.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Lameness	426	319	250	189	296	217	177	257	187	108	309	240	2975
Fistulae	124	53	47	28	58	49	56	37	33	36	39	32	587
Bursatte	2					7	11	5	1	1	1		28
Cornstalk disease	10	8	2	4	2	1	1				1		29
Cerebro spinal meningitis	4	4	7	5	3		6	4	7	2	5	9	59
Parturient apoplexy	72	42	43	40	68	63	52	20	32	29	37	30	528
Periodic ophthalmia	61	31	28	28	32	32	30	26	32	14	35	19	268
Pleurisy	39	23	35	16	34	9	12	18	30	34			250
Pneumonia	120	51	40	31	57	19	37	29	30	36	44	49	543
Laminitis	69	38	39	24	46	40	60	43	39	26	41	24	489
Enterites	29	17	17	7	22	8	17	27	20	14	18	21	217
Gastritis	30	13	14	12	25	21	22	13	23	38	30	25	266
Colic	464	120	222	183	223	187	173	163	186	150	129	236	2042
Azoturia	188	135	116	90	69	19	19	13	14	22	30	46	759
Canine distemper	79	100	53	37	37	27	18	20	24	26	43	38	502
Specific ophthalmia (of cattle)	28	16	15				1	7					67
Sporadic Aphthae	4	11	1		2	1			4		3	4	30
Tetanus	51	20	19	14	25		4		12	19	31	23	218
Tuberculosis	14	6	5	2	5						33	2	67
Influenza	537	264	268	148	174	142	134	140	168	147	253	209	2608
Rabies	4							2	4	2			12
Glanders	5	1	2		4	1	2					5	24
Abortion—cows	12	7	6	2							11	4	42
Abortion—mares	3	2	6									4	15
Anthrax	3					4	1						8
Actinomycosis	30	14	7	7	15	5	7	2	10	9	6	6	120

A close study of this table will show that in 1897 there was little difference in the number of cases occurring in the different months of the year. With the exception of azoturia, which shows an increase for the months of February, March, April and May, bursatte, which is reported for July, August and September, and a slight increase in the number of cases of laminitis for July, August, September and October, practically no differences are observed. Pneumonia, tetanus and parturient apoplexy do not occur more often at one time than at another. It also shows that parturient apoplexy and tetanus are much more common diseases than generally supposed.

A table of the distribution of the diseases in the State has not been prepared for publication, as observations were not taken at a sufficient number of points. The reports are interesting, in that they are indicative of the frequent occurrence of some diseases in some places and rare in others. Fistulae is a disease supposed to be due to injuries, but is found to occur much more frequently in some places than others. The difference is too great to be ascribed to accidental causes. If reports could be obtained upon such diseases for several years it might serve to throw some new light upon their pathology. These reports also serve as an index of what diseases to study.

Hog cholera is the most important disease in the State, because of the immense losses it causes. The losses for 1897 are only about 70 per cent. as much as in 1896. The townships bordering upon the rivers lose 50 per cent. more than those in the second tier, and 70 per cent. more than those in the third tier—indicating that it is a water-borne disease.

Glanders occurred in several places in the State, principally in the northwestern part. In all about 90 animals were affected; most of them came from Chicago.

Specific ophthalmia of cattle caused less trouble than usual in the Kankakee pastures.

Texas fever (splenic apoplexy) occurred at three places in the State, due to shipping cattle from the South, against the government regulations. The losses were small.

Sheep scab is spreading, and it is believed that much of it is caused by purchase of sheep shipped into the State for feeding purposes and contracting the disease in infected pens and cars.

The large Bur-Headed Worm *(Echinothorynchus gigas)* of the hog has caused considerable loss to the intestines of hogs as sausage casings. Several packers have stated that their losses on this product alone would aggregate several thousand dollars.

Respectfully submitted,

A. W. BITTING,
Veterinarian.

REPORT OF THE AGRICULTURAL DEPARTMENT.

To C. S. Plumb, Director:

Sir—The lines of work pursued by the department during the year were in the main a continuation of the work previously begun. The following new lines of work were taken up:

1. A comparison of forage crops.
2. A comparison of various leguminous plants.
3. Relation of size of plat to yield of wheat.
4. Relation of heavy and light seed wheat to yield.
5. Early and late sowing of winter oats.
6. Deep and shallow planting of corn.
7. Test of fertilizers applied in combination and quantities to represent current farm practice.

So far as results or conclusions of value were reached, these newly begun experiments will be referred to later in the body of the report.

The early part of the growing season of 1897 was quite unfavorable to spring crops. This was especially true of corn, and a poor stand resulted. These unfavorable conditions interfered much with the experiment with this cereal for the year.

The cold weather following the sowing of oats on ground that had not been plowed resulted in a strong growth of weeds, which did much to hold the oats in check and reduce the yield of this crop.

Although unfavorable to spring crops, the early part of the season was unusually favorable to winter wheat, as was shown by the rapid recuperation of this crop after the winter months were passed.

I. EXPERIMENTS WITH VARIETIES.

1. *Wheat*—Number of varieties grown in 1897, 13; time under trial, 1 to 14 years; average yields ranging from 11 to 30 bushels;

yields in 1897 ranged from 9 to 30 bushels; more promising varieties, Russian, Michigan amber, Velvet chaff, bearded Winter fife.

2. *Oats*—Number of varieties grown in 1897, 21; time under trial, 1 to 9 years; average yields ranged from 30 to 55 bushels; yields in 1897 ranged from 22 to 35 bushels; more promising varieties, white Russian, black oats, white Swede and Black prolific.

3. *Grasses and Clovers*—This is a continuation of last year's experiment with grasses and clovers, referred to in the annual report for 1896. The red horse sorrel (*Rumex acetosella*) has largely taken possession of many of the plats so that the yields were very much reduced. It was impossible to determine, at all closely, the effect of the horse sorrel upon the yields of these plats, hence the figures in the table below can only be considered as roughly approximate. The plats are of the same size and the varieties marked with a star were cut twice.

VARIETY.	PLAT YIELD IN POUNDS.	DESCRIPTION.
Lathyrus sylvestris	780	Good stand; very slow growth; not liked by live stock, either green or cured.
*Alfalfa	317	Badly mixed with common clover, owing to its slow growth the year previous.
*Alsike clover	372	Considerably mixed with common red clover.
*Common red clover	420	Fine growth.
*Mammoth clover	416	Fine growth; slightly mixed with common red clover.
Festuca elatior (Taller fescue).	120	Imperfect stand; slight growth.
Lolium perenne (English rye grass).	105	Poor stand; poor growth.
Bromus inermis (Awnless brome grass).	60	Very poor stand.
Bromus pratensis (Meadow brome grass).	35	Very poor stand.
*Orchard grass	120	Headed May 1; ten days earlier than any other variety; stands drouth well; good pasture grass.
*Timothy	165	
Red top	220	A good but slow growth; headed June 25.
Avena elatior (Tall oat grass).	145	A very poor stand; an early grass and strong grower.
Grass mixture No. 1 (Orchard grass, tall oat grass, meadow fescue and common red clover).	315	Only red clover and orchard grass showed to any extent in the crop.
*Grass mixture No. 2 (Timothy, red top, taller fescue and mammoth clover).	410	The crop was composed chiefly of clover.

Common red clover had invaded to a greater or less extent the plats of alfalfa and alsike clover, orchard grass, timothy and red top, and doubtless increased the yields of these plats somewhat. The seed of the newer varieties seemed to lack greatly in vitality. Orchard grass, timothy, red top and the several varieties of clover named, germinate well and give good crops here. The other varieties cannot be recommended on the results obtained at this Station. *Lathyrus sylvestris* is entirely too slow to be grown *in rotation.* This is also true of alfalfa, although it is not so slow as the other.

4. *Forage Crops.* Barteldes & Co., of Lawrence, Kansas, sent the Station last spring several packages of seeds of forage crops. Owing to the small quantities of seed it was impossible to sow plats of any considerable size, so the seed was deposited in drills. Of course no satisfactory record of the yields could be made under these conditions. The following field notes will give some idea of the growth of these plants.

Dwarf Essex rape. First crop 12 to 14 inches high; second crop four to six inches high; an excellent forage crop on rich soils, sufficiently moist.

Idaho field pea. This is a bushy plant with a very spreading habit of growth. The stand was very poor. It is a vigorous grower, but does not promise a large amount of forage. Under favorable conditions it will probably produce quite a yield of grain. In growth it resembles slightly the lupines.

African millet. This is an excellent grower, but it was sown too thin for the best results. It grew eight to ten feet high and resembles sorghum.

Yellow Milo maize. This grew five to seven feet high and had a very stocky growth. It would doubtless do much better as a forage crop if sown quite thickly.

Brown Durrha corn. This grew six to nine feet high and produced an excellent stand and would doubtless prove a good fodder crop.

Brazilian flower corn. This closely resembles common field corn, but is greatly inferior to it.

Red Kaffir corn. Height five to seven feet. A good crop for soiling. It is a sorghum.

White Kaffir corn. This resembles red Kaffir corn except that the heads are lighter in color.

Jerusalem corn. Stalks large; heads thick, yielding an abundance of seed.

Black rice corn. First crop eight to 12 feet high; second crop two to four feet high, notwithstanding a severe drouth. This would doubtless prove an excellent soiling crop.

II. EARLY AND LATE SOWING OF WINTER OATS.

Seed of winter oats, grown on the Station farm in 1896, was sown in the fall of that year at three different dates, namely—Sept. 8, 17 and 26. The first sowing came up well and wintered in good shape; the second germinated well but did not make so rank a growth as the first; the third was very slow to germinate and the fall growth was poor. In the spring the oats were found to be entirely killed out on all three plats. In the three years' test of winter oats the crop was killed out absolutely the first and third years, and the return the second year was so indifferent that it would seem extremely unwise to attempt the growing of winter oats in this latitude.

III. FERTILIZERS ON OATS.

The ground on which this experiment was conducted is considerably worn, the result of growing fifteen or more crops without manure or fertilizer. The purpose of the experiment is to determine the effect of kinds and quantities of commercial fertilizers that approximately represent general farm practice. The experiment contemplates a four-course rotation consisting of corn, oats, wheat and clover. In 1896 corn was grown on all the plats of the series without any fertilizers whatever, the aim being to ascertain the natural fertility of the plats. In 1897 the plats were seeded to oats. The fertilizers were scattered broadcast immediately after the sowing of the oats. The series of plats designated as "F" in the table below are located on ground which had been in a regular rotation, while the series below designated as "H" was devoted entirely to growing grain crops of the same length of time. The kinds and quantities per acre of fertilizers and yields per acre of grain and straw are hown in the tables which follow:

Yields of Oats on Series F.

No.	Fertilizers Used.	Pounds fertilizer per acre.	Yields per acre. Bushels grain.	Pounds straw.
1	None		48.19	1,292
2	Acidulated phosphate Nitrate of soda Muriate of potash	250 37.5 30	63.90	2,092
3	Acidulated phosphate Nitrate of soda Muriate of potash	125 37.5 30	62.19	1,858
4	Acidulated phosphate Nitrate of soda Muriate of potash	62.5 37.5 30	60.94	1,944
5	Acidulated phosphate Nitrate of soda Muriate of potash	125 37.5 15	68.12	1,686
6	None		53.28	1,519
7	Acidulated phosphate Nitrate of soda Muriate of potash	125 37.5 7.5	67.97	1,987
8	Acidulated phosphate Nitrate of soda Muriate of potash	125 18.7 30	62.81	1,772
9	Acidulated phosphate Nitrate of soda Muriate of potash	125 9.4 30	58.75	2,093
10	None		68.28	1,331

YIELDS OF OATS ON SERIES H.

No.	FERTILIZERS USED.	Pounds fertilizer per acre.	Yields per acre.	
			Bushels grain.	Pounds straw.
1	None	....	53.90	940
2	Acidulated phosphate Nitrate of soda Muriate of potash	250 75 60	51.56	1,849
3	Acidulated phosphate Nitrate of soda Muriate of potash	125 75 60	56.25	1,560
4	Acidulated phosphate Nitrate of soda Muriate of potash	125 75 30	56.56	1,635
5	Acidulated phosphate Nitrate of soda Muriate of potash	125 75 30	64.69	1,826
6	None	....	50.78	1,567
7	Acidulated phosphate Nitrate of soda Muriate of potash	125 75 15	68.91	1,797
8	Acidulated phosphate Nitrate of soda Muriate of potash	125 37.5 60	58.75	1,886
9	Acidulated phosphate Nitrate of soda Muriate of potash	125 18.7 60	59.37	1,416
10	None	....	52.50	1,363

IV. DEEP AND SHALLOW CULTURE OF CORN.

Time under trial, nine years; range in depth of culture, one to four inches; average yield per acre as follows:

From cultivation, 1 inch deep........................44 bushels.
From cultivation, 1 inch deep........................43 bushels.
From cultivation, 3 inch deep........................41 bushels.
From cultivation, 4 inch deep (last 4 years only)....31 bushels.

Yields in 1897—

Culture, 1 inch deep..............................43 bushels.
Culture, 2 inch deep..............................42 bushels.
Culture, 3 inch deep..............................43 bushels.
Culture, 4 inch deep..............................38 bushels.

The low average yields in the table are due to drouths in 1893, 1894, 1895 and 1897.

V. EXPERIMENTS WITH CORN CULTIVATORS.

The following named implements have been under trial in this experiment:

1. *The Albion spring-tooth wheel cultivator*, with six teeth in each gang.

2. *The Tower's surface cultivator*, whose reversible, flat blades shave the soil, but stir it only to a very slight depth.

3. *The Hoosier cultivator*, which has flat blades, whose action is much the same as that of Tower's cultivator.

4. *The Corn plow*, consisting of two shovels in each gang. Bull tongues have been used instead of the inside shovel for the first and second cultivations, as a rule.

Name of Cultivator.	Time under trial.	Yield per acre.
Albion spring tooth	9 years	55 bushels.
Corn plow	9 years	53 bushels.
Hoober cultivator	8 years	53 bushels.
Tower's cultivator	5 years	52 bushels.
Breed's weeder and harrow	4 years	50 bushels.

The above showing is unfair to the implements which have been under trial only four or five years, owing to the drouths of 1893, 1894, 1895 and 1897.

The Albion spring-tooth cultivator has produced a little better average yield than any other implement. This implement does very effective work and is easily managed. It is considered the best one of the cultural implements under trial.

VI. EFFECT OF PREVIOUS MANURING ON YIELD OF CORN.

The ground devoted to this experiment has grown corn continuously since 1880. In 1883 and 1884 fresh horse manure was applied to alternate plats, amounting for the two years, to about 50 tons per acre. No manure has been used in this series of plats before or since the two years named. The manured plats show an average increased yield per acre of more than nine bushels. The aggregate increase from manure in 15 crops has been 128.4 bushels to the acre. The increase in 1897 was 2.4 bushels to the acre, showing that the manure has not yet been exhausted.

VII. EFFECT OF HEAVY AND LIGHT APPLICATIONS OF MANURE AND FERTILIZER.

This experiment was begun in 1889, and has been carried on continuously since. The plan of the experiment includes a variety of crops to be grown in shorter or longer rotations, and also the continuous growing of wheat and corn on the several series of plats. Certain plats in each of the several series received heavy and light applications of fertilizers or manure.

Frequently recurring and severe drouths have thus far greatly interfered with this series of experiments. In some cases the drouth has been so intense as to prevent the manure or fertilizer from having any beneficial effect upon the yield.

At the outset the purpose of this experiment was to determine the effects of applying manure or fertilizer to the soil in quantities sufficient to meet the demands of a maximum crop. This was soon found to be unprofitable, as frequently recurring drouths prevented the crops from getting full benefit from the fertilizer. During the last two or three years of the experiment the aim has been only to apply such quantities of fertilizers and manures as might prove profitable. The results to date are somewhat conflicting. In general it may be stated that the heavier applications of fertilizer have proved quite unprofitable. The lighter applications of fertilizers

have sometimes returned a profit. Heavy manuring has proved quite unprofitable in some cases, and as a rule less profitable than light applications of manure. The lighter applications of manure have as a rule proved quite profitable. The soil in which these experiments are being conducted is still fairly fertile. In an average season it would doubtless produce 20 bushels of wheat and 40 bushels of corn without fertilizer. The experiment will need to be conducted several years before very definite conclusions can be reached.

VIII. CONTINUOUS GROWING OF CLOVER.

This experiment, like the preceding, was begun in 1889. The series of plats devoted to it have been kept constantly in clover since that time, the ground being broken and reseeded to clover whenever the stand began to fail. The purpose of the experiment is to determine the effect of continuous clover growing and removal of the crop on the nitrogen of the soil. Certain plats of the series received manure or fertilizer and certain plats received no fertilizer of any kind. The crop has been regularly removed each year from all the plats. The results thus far indicate what many other experiments have shown--that the continuous growing of any one crop tends to reduce the yield. It will take some years yet to determine the effect of the clover upon the nitrogen content of the soil.

The Assistant Agriculturist, Mr. W. B. Anderson, has had charge of nearly all the details of the field work, and he has also tabulated the results of the experiments. His work has been carefully performed, and I believe the results are therefore practically correct.

Respectfully submitted,

W. C. LATTA,
Agriculturist.

APPENDIX.

ACKNOWLEDGMENTS.

The following gifts have been made to the Station during the year, and to the givers of these thanks are herewith rendered:

United States Department of Agriculture, Washington, D. C. Numerous publications, seeds, etc. Also 500 pounds sugar beet seeds.

W. Atlee Burpee & Co., Philadelphia, Pa. Garden and flower seeds.

The Deming Co., Salem, Ohio. One each of Bordeaux spray, "Deming-Vermorel" spray combination nozzle, and hose coupling and hose stock.

J. S. Lintner, New York State Entomologist, Albany. Eleventh report of the New York State Entomologist for 1895.

C. W. Bush, Granville, Ill. One peck of Early Jewel oats.

J. W .Austin, Pilot's Point, Texas. Twelve of Austin's Improved Dewberry plants.

J. McLain Smith, Secretary, Dayton, Ohio. Vols. VIII and IX, Red Polled Herd Book.

E. Tully, Penza, Ohio. Tubers Early Trumbull potatoes.

M. Crawford, Cuyahoga Falls, Ohio. One dozen Clark blackberry plants.

H. C. Marsh, Muncie, Ind. One-half peck seed potatoes.

Peter Henderson & Co., New York City. Seeds.

Clifton George, Lathrop, Mo. Engraving of pig.

Prof. C. P. Fox, Moscow, Idaho. Package Idaho coffee bean. *(Cicer areitimum)*.

E. Rauh & Sons, Indianapolis, Ind. Sack bone meal.

W. H. Bowker, Boston, Mass. Bottle nitragin.

Wm. R. Sessions, Secretary, Boston Mass. Report Massachusetts State Board of Agriculture for 1896.

J. H. Maiden, Government Botanist, Sydney, New South Wales. Reports on New South Wales plants worth cultivating and in the Government Botanic Gardens.

R. C. Lake, Indianapolis, Ind. Half gallon can lice exterminator.

F. Barteldes & Co., Lawrence, Kansas. Packets of seeds.

DeLaval Separator Co., Chicago, Ill. Repairs on Separator.

Frederick L. Houghton, Secretary, Brattleboro, Vt., Vol. XIV Holstein-Friesian Herd Book.

Northwestern Seed Co., Faribault, Minn. Seeds.

H. M. Dunlap, Secretary, Transactions Illinois State Horticultural Society for 1896.

Nicholas Chemical Co., New York City. Barrel Laurel Green insecticide.

Deering Co., Chicago, Ill. Repairs to mower.

Clizbe Bros., Chicago, Ill. Sickle grinding machine.

Genessee Salt Co., Chicago, Ill. Barrel dairy salt.

German Kali Works, New York City. Pamphlets on potash manuring.

John Lewis Childs, New York; Henry A. Dreer, Philadelphia, Pa.; J. M. Thornburn, New York; R. & J. Farquhar, Boston, Mass.; Peter Henderson & Co., New York; American Bulb Co., seeds of calceolarias and cinerarias.

E. K. Morris, Secretary, Indianapolis, Ind. Vols. IV, V, VI, National Berkshire Record.

W. H. Morris, Secretary, Indianapolis, Ind. Vols. I, II, III, IV, Standard Chester White Record, and Vols. XV, XVI and XVII, Central Poland China Record.

Carl Friegau, Secretary, Dayton, Ohio. Vol. VI, American Chester White Record, and Vol. I to IV of Todd's Improved Chester White Swine Record.

C. R. Thomas, Secretary, Independence, Mo. Vol. XVI, American Hereford Record.

Chris. Hansen's Laboratory, Little Falls, N. Y.; O. F. Douglas Co., Boston, Mass., and Conn. Butter Culture Co., Waterloo, Iowa, Butter Cultures.

W. W. Chapman, Secretary, London, England, Vol. VI, Southdown Flock Book for 1897.

PERIODICALS.

The publishers of the following periodicals have kindly sent them to the Station during the year. These are leading journals and are used for frequent consultation both by the Station Staff and the agricultural students of the University:

UNITED STATES.

American Agriculturist	New York.
Agricultural Epitomist	Indianapolis, Ind.
American Creamery	Chicago, Ill.
Agricultural Student	Columbus, Ohio.
American Cultivator and Poultry Keeper	Los Angeles, Cal.
American Florist	Chicago, Ill.
American Gardening	New York, N. Y.
American Grange Bulletin	Cincinnati, Ohio.
American Horticulturist	Wichita, Kan.
American Sheep Breeder and Wool Grower	Chicago, Ill.
Baltimore Sun (weekly)	Baltimore, Md.
Breeders' Gazette	Chicago, Ill.
Colman's Rural World	St. Louis, Mo.
Creamery Journal	Waterloo, Iowa.
Dakota Field and Farm	Sioux Falls, S. D.

Drainage Journal	Indianapolis, Ind.
Elgin Dairy Report	Elgin, Ill.
Experiment Station Record	Washington, D. C.
Farm and Dairy	Ames, Iowa.
Farm and Fireside	Springfield, Ohio.
Farm and Home	Chicago, Ill.
Farm, Field and Fireside	Chicago, Ill.
Farm Journal	Philadelphia, Pa.
Farm Poultry	Boston, Mass.
Farmers' Call	Quincy, Ill.
Farmers' Guide and Home Companion	Huntington, Ind.
Farmers' Home	Dayton, Ohio.
Farmers' Magazine	Springfield, Ill.
Farmers' Review	Chicago, Ill.
Farmers' Voice	Chicago, Ill.
Field and Farm	Denver, Colo.
Grange Visitor	Lansing, Mich.
Gentleman Farmer	Chicago, Ill.
Hoard's Dairyman	Fort Atkinson, Wis.
Holstein-Friesian Register	Brattleboro, Vt.
Home and Farm	Louisville Ky.
Hospodar	Omaha. Neb.
Indiana Farmer	Indianapolis, Ind.
Industrial American	Lexington, Ky.
Industrialist	Manhattan, Kan.
Iowa Homestead	Des Moines, Iowa.
Jersey Bulletin	Indianapolis, Ind.
Journal of Agriculture	St. Louis, Mo.
Kansas Farmer	Topeka, Kan.
Live Stock Journal	Indianapolis, Ind.
Live Stock Report	Chicago, Ill.
Louisiana Planter	New Orleans, La.
Market Garden	Minneapolis, Minn.
Michigan Farmer	Detroit, Mich.
Mirror and Farmer	Manchester, N. H.
Montana Fruit Grower	Missoula, Mont.
National Stockman and Farmer	Pittsburg, Pa.
Nebraska Farmer	Lincoln, Neb.
New England Farmer	Boston, Mass.
New England Florist	Boston, Mass.
North American Horticulturist	Monroe, Mich.
Orange Judd Farmer	Chicago, Ill.
Oregon Agriculturist	Portland, Oregon.
Pacific Coast Dairyman	Tacoma, Wash.
Pacific Rural Press	San Francisco, Cal.
Practical Dairyman	Chatham, N. Y.
Practical Farmer	Philadelphia, Pa.
Prime's Crop Bulletin	Dwight, Ill.
Progressive South	Richmond, Va.
Public Ledger (daily)	Philadelphia, Pa.
Reliable Poultry Journal	Quincy, Ill.

Rural Northwest	Portland, Oregon.
Silent Hoosier	Indianapolis, Ind.
Southern Cultivator and Dixie Farmer	Atlanta, Ga.
Southern States	Baltimore, Md.
Success With Flowers	West Grove, Pa.
Sugar Beet	Philadelphia, Pa.
Wallace's Stockman and Farmer	Des Moines, Iowa.
Weather and Crops	Chicago, Ill.
Western Soil Culture	Minneapolis, Minn.
Wisconsin Agriculturist	Racine, Wis.
Wool Review	New York, N. Y.

The following periodicals have been received during the year from Indiana publishers:

Advertiser, The	Medaryville.
Banner, The	Bluffton.
Enterprise, The	Richmond.
Herald, The	Cayuga.
Herald, The	Jasper.
Herald, The	Lyons.
Home Journal, The	Lafayette.
Hoosier State, The	Newport.
Journal, The	Osgood.
Journal, The	Rossville.
Lafayette Commercial Gazette, The	Lafayette.
Leader, The	Newburgh.
Magnet, The	Angola.
Mail, The	Columbia City.
Mail, The	Milford.
Mennonitische Rundschau	Elkhart.
News, The	Petersburg.
Recorder, The	Rising Sun.
Register, The	Crown Point.
Times, The	Parker City.
Wayne Farmer, The	Hagerstown.

FOREIGN.

Agricultural Gazette of New South Wales	Sydney, Australia.
Farmers' Advocate	London, Ontario, Can.
Farming	Toronto, Ontario, Can.
La Produccion Argentina	Buenos Ayres, Arg. Rep.

In addition to the above the following periodicals are subscribed for by the Station and are on file for reference:

Analyst, The	London, England.
Annalen der Chemie	Leipzig, Germany.
Berichte der Deutschen Botanischen Gesellschaften	Berlin, Germany.
Botanisches Centralblatt	Cassel and Marburg.

Botanische Zeitung .... Leipzig.
Bulletin le la Societe Chemique de Paris .... Paris, France.
Centralblatt für Bakteriologie und Parasitenkunde ...... Jena, Germany.
Entomologist .... London, England.
Gardeners' Chronicle .... London, England.
Journal für Landwirthschaftlicher .... Berlin, Germany.
Journal of the Royal Agricultural Society of England .. London, England.
Journal of the Chemical Society .... London, England.
Landwirthschaftliche Jahrbücher .... Berlin, Germany.
Live Stock Journal .... London, England.
Veterinary Journal .... London, England.
Veterinarian .... London, England.
Zeitschrift für Analytische Chemie .... Wiesbaden, Germany.
Zeitschrift für Pflanzenkrankheiten .... Stuttgart.

TREASURER'S REPORT EXPERIMENT STATION.

As Treasurer of Purdue University, I hereby submit my report of all moneys received during the year ending June 30, 1897, on account of Experiment Station funds:

From U. S. Government..............................	$15,000 00
From farm receipts..................................	1,134 86
Total....................................	$16,134 86

JAMES M. FOWLER,
Treasurer Purdue University.

FINANCIAL STATEMENT.

The Agricultural Experiment Station of Indiana, in account with the United States, for the year ending June 30, 1897:

DEBIT.

Received of the Treasurer of the United States, receipts as shown by the Treasurer's report	$15,000 00

CREDIT.

Salaries	$8,817 13	
Labor	2,834 53	
Publications	787 56	
Postage and stationery	106 63	
Freight and express	97 73	
Heat, light and water	382 16	
Chemical supplies	305 76	
Seeds, plants and sundry supplies	539 24	
Fertilizers	25 78	
Feeding stuffs	219 32	
Library	165 84	
Tools, implements and machinery	225 66	
Furniture and fixtures	68 17	
Scientific apparatus	7 75	
Live stock	175 50	
Traveling expenses	102 27	
Contingent expenses	16 48	
Building and repairs	122 49	
Total		$15,000 00

I hereby certify that the above is a correct statement of expenditures in Station fund for year ending June 30, 1897.

E. A. ELLSWORTH,
Secretary Board of Trustees.

IMPROVEMENT FUND EXPERIMENT FARM FOR YEAR ENDING JUNE 30, 1897.

DEBIT.

Balance, June 30, 1896		$930 63
Receipts from farm for 1897		1,134 86

CREDIT.

Salaries	$460 70	
Labor	553 45	
Publications	181 10	
Postage and stationery	7 40	
Freight and express	22 83	
Heat, light and water	50 00	
Seeds, plants and sundry supplies	97 47	
Feedings stuffs	4 00	
Library	3 66	
Tools, implements and machinery	19 30	
Furniture and fixtures	6 70	
Scientific apparatus	5 85	
Live stock	304 50	
Traveling expenses	8 55	
Contingent expenses	237 10	
Building and repairs	22 90	
Balance	79 98	
	$2,065 49	$2,065 49

I hereby certify that the above is a correct statement of expenditures from Improvement fund for year ending June 30, 1897.

E. A. ELLSWORTH,
Secretary Board of Trustees.

PURDUE UNIVERSITY.

ELEVENTH REPORT

OF THE

Agricultural Experiment Station.

LAFAYETTE, INDIANA,

COVERING THE SIX MONTHS ENDING JUNE 30, 1898.

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.
1899.

THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
INDIANAPOLIS, February 23, 1899.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF AUDITOR OF STATE,
INDIANAPOLIS, February 24, 1899.

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

W. H. HART,
Auditor of State.

Returned to the Auditor of State, with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

CHAS. E. WILSON,
Private Secretary.

Filed in the office of the Secretary of State of the State of Indiana, this 24th day of February, 1899.

UNION B. HUNT,
Secretary of State.

Received the within report and delivered to the printer this 24th day of February, 1899.

THOS. J. CARTER,
Clerk Printing Bureau.

To the Governor of Indiana:

I herewith transmit the annual report of the Purdue University Agricultural Experiment Station for the six months ending June 30, 1898.

Very respectfully yours,

CHAS. B. STUART,

President Board of Trustees.

Purdue University, Lafayette, Ind., November 16, 1898.

President Board of Trustees, Purdue University, Lafayette, Ind.:

Dear Sir—I herewith submit the annual report of the Agricultural Experiment Station of Indiana, the same being required by Section 3 of an act of Congress entitled, "An act to establish agricultural experiment stations in connection with colleges established in the several States under provisions of an act approved July 2, 1862, and of the acts supplemental thereto."

Heretofore this report has been submitted for the year ending December 31st. In accordance with a request from the United States Department of Agriculture, this and succeeding reports will be made for the year ending June 30th. The present report, therefore, covers the six months ending June 30, 1898.

Respectfully submitted,

W. E. STONE.
Vice-President.

Purdue University, Lafayette, Ind., November 16, 1898.

BOARD OF CONTROL.

Charles B. Stuart, President......Lafayette, Tippecanoe County.
William A. Banks....................Laporte, Laporte County.
Sylvester Johnson ....Irvington, Marion County.
David E. Beem........................Spencer, Owen County.
Job H. VanNatta................Lafayette, Tippecanoe County.
Benjamin Harrison ....Indianapolis, Marion County.
William H. O'Brien...........Lawrenceburg, Dearborn County.
James M. Barrett...................Fort Wayne, Allen County.
John Martin ....Brookville, Franklin County.

JAMES H. SMART, LL. D.,
President of the University.

EDWARD A. ELLSWORTH,
Secretary.

JAMES M. FOWLER,
Treasurer.

STATION STAFF.

Charles S. Plumb, B. S	Director.
William C. Latta, M. S	Agriculturist.
James Troop, M. S	Horticulturist.
Henry A. Huston, A. M., A. C	Chemist.
Joseph C. Arthur, D. Sc	Botanist.
Arvill W. Bitting, D. V. M	Veterinarian.
William Stuart, M. S	Assistant Botanist.
William B. Anderson, B. S	Assistant Agriculturist.

ELEVENTH REPORT

OF THE

Purdue University Agricultural Experiment Station

REPORT OF THE DIRECTOR
AND OTHER OFFICERS.

To President James H. Smart:

Sir—The following very brief report is for the six months ending June 30, 1898. It has been customary during the past ten years, to have the Station report cover the calendar year ending December 31st, but upon the recommendation of the Director of the Office of Experiment Stations of the United States Department of Agriculture, a change is herewith made, by which in future, the annual report will cover the twelve months ending June 30th.

The purpose of this change is to publish the annual report so that it may be available to the Department of Agriculture officials in making up the report of that department for Congress. There will also be some advantage in this for the Station Staff, in giving them a season of more relaxation in preparing manuscript for the printer during the relief from class work in summer. Heretofore, the report has been prepared in winter during a season busy with University duties.

It is consequently the purpose of the Director, to make this report for the six months quite short, and the following one for the year ending June 30th, somewhat extended, and containing details of experimental work.

The Experimental Work during these six months is of less duration than during the remaining months, owing to the fact that the Station Staff is occupied till the latter part of March, to a considerable extent, in teaching. In the Chemical Department a considerable amount of time has been given to preparation work for the sugar beet experiments for 1898. A very large amount of seed furnished by the United States Department of Agriculture has been distributed to several hundred farmers, and 768 samples of seed have been mailed with directions for planting and cultivation. The sugar beet work this year, through the intelligent and interested co-operation of many farmers, promises to give a much greater return to the Station in the way of information, than for any previous year. Some miscellaneous analytical work has been in progress relating to buckwheat, soils, etc. The work of this Department has also been curtailed, owing to the lack of an Assistant Chemist for five of the six months.

In the *Veterinary Department* a large amount of original work has been conducted on the physiology of the milk gland and the process of milk secretion. This work is now about completed, and is in partly manuscript form, and will be published during the ensuing twelve months. The Veterinarian has also conducted, personally or through an assistant, a large number of tuberculin tests, and has assisted quite a number of interested dairymen in securing tuberculin tests through the aid of local veterinarians. In every case the Station has secured records of these tests, so that there is now on file here at the Station several thousand records of such tests. In addition to this work, some time has been devoted to hog cholera studies, and to giving more or less assistance to stockmen having sick, diseased or injured animals.

In the *Horticultural Department* three experiments begun late in 1897, were continued during the winter, viz.: (1) Sub vs. surface irrigation of lettuce; (2) sub-irrigation of lettuce, first, by means of a soft brick bottom to the bed, to facilitate even water distribution, and second, by means of tile; (3) sub-irrigation vs. surface irrigation for tomatoes. The results of this work favor sub-irrigation, both as to weight of crop and period of maturity. In the orchard, considerable work in spraying various fungicides and insecticides on the trees and vines was carried on, especially with the

arsenites, whale oil soap, chloronaptholeum and Bordeaux mixture. A limited amount of variety tests with fruits and vegetables are in progress.

In the *Botanical Department* lettuce was grown upon a subwatered bench, subject to the use of different combinations of chemical fertilizers to note the effect of potash, phosphoric acid and nitrogen on the crop. Pot culture studies of lettuce in the same field were also made. The study of the relation of weight and size of seed to resulting crop is being continued, peas and beans being grown this year for that purpose. The work in the vegetation house with plants in pots included the lettuce, beans and roses, subject to different amounts and kinds of plant food. Mushroom culture has been undertaken in the mushroom pit, but hardly with success. This work, however, will be continued. Considerable attention has been given to examinations of plants suffering from fungus diseases, and especially rusts and smuts, and the curl of peaches, and pockets of plums.

The *Agricultural Department* was busily engaged in April and May in making the experimental plantings of corn, oats, kaffir corn, soy beans, cowpeas, sunflowers, sorghum, Russian and Idaho field peas and some forage crops, grasses, etc., and attending to the necessary cultural work in connection with these crops. The work with forage crops this year at the Station is on a more extensive scale than heretofore, and interesting results from these studies are looked for. Among the varieties of wheat on trial, a number from the United States Department of Agriculture seem to be failures. Quite a variety of tests of different kinds bearing on dates of planting, depth, use of cultural implements, methods of seeding, etc., are in progress, more specific information concerning which can be found in the report of the Agriculturist further on.

Feeding experiments with live stock have been in constant operation during the past six months. These particularly bear on the use of grain rations for suckling lambs and pigs, and on other rations for growing pigs.

Four half-acre fields have been planted to mangels, each to a different variety, and these fields are under experimental observation. The varieties will be analyzed and the crop fed next winter.

The Station Staff remains as for some years, excepting for the resignation of Mr. J. M. Barrett, Assistant Chemist, who severed

his relations with the Station February 1st, to accept a more lucrative place elsewhere. Mr. Barrett was always a most faithful and intelligent employe of the Station. Mr. A. H. Bryan, a graduate of Purdue University, will on July 1st, become Assistant Chemist in place of Mr. Barrett.

Improvements have been made on but a limited scale; but some much needed fencing has been erected. Eighty-two rods of Shimer woven wire fence, on steel posts, have been erected eastward from the west side of the farm, along the main highway, terminating at the lane east of the horticultural grounds. This beautiful and strong fence replaces a wooden one that was a disgrace to the institution. About one hundred and thirty-five rods of Kitselman woven wire fence was also erected on the south side of the farm, fifty-eight of which was along by the railway track, shutting it off from the small pastures, the remainder being used in building more small acre pasture lots, connecting with the pig and sheep quarters. The fencing of the Agricultural Department and Station is now largely in good repair, excepting in a small way, and for the first time in many years. In June, the old portion of the Station building was reshingled and a skylight placed in the roof, and the roof over the general chemical laboratory reshingled and most of the old shutter ventilators taken out and the remaining spaces ceiled up.

Publications have been issued as follows during the past six months:

PAMPHLET BULLETINS.

Bulletin No. 68, Vol. IX, March, 1898, pp. 32, Figs. 13. The sugar beet in Indiana. By H. A. Huston and J. M. Barrett.

Bulletin No. 69, Vol. IX, March, 1898, pp. 33-40. Insecticides, fungicides and spraying. By James Troop.

Bulletin No. 70, Vol. IX, May, 1898, pp. 41-52. Figs. 14-16. The relation of water supply to animal diseases. By A. W. Bitting.

Bulletin No. 71, Vol. IX, June, 1898, pp. 53-64.

1. **Cornmeal and shorts as food for pigs. By C. S. Plumb and W. B. Anderson.**
2. **Skim milk as food for young growing chickens. By W. B. Anderson.**

NEWSPAPER BULLETINS.

These bulletins are distributed to periodicals published in Indiana, and to a limited degree outside of the State, 700 being printed in each edition. They are from 450 to 500 words long, and deal

with important and timely topics. Communications from over one hundred editors in the State this spring, show warm appreciation of their contents, with a desire for their continuation.

No. 53. March 2, 1898. Spring wheat for Indiana. By W. C. Latta, Agriculturist.

No. 54. March 25, 1898. Strawberry notes. By James Troop, Horticulturist.

No. 55. March 25, 1898. Some desirable varieties of raspberries and blackberries. By James Troop, Horticulturist.

No. 56. April 20, 1898. The protection of crops from frosts. By H. A. Huston, Chemist.

No. 57. April 27, 1898. Cowpea culture in the North. By W. C. Latta, Agriculturist.

No. 58. May 5, 1898. Dipping sheep for ticks. By A. W. Bitting, Veterinarian.

No. 59. May 20, 1898. Fruit prospects in Indiana. By James Troop, Horticulturist.

No. 60. June 4, 1898. Peach leaf curl and plum pockets. By J. C. Arthur, Botanist.

No. 61. June 29, 1898. Feeding skim milk to growing chickens. By C. S. Plumb, Director.

Mailing List. On June 30th, the mailing list of the Station numbered 15,324 names, and the pamphlet bulletins were distributed as follows:

To persons in Indiana	12,320
To persons outside of Indiana	2,144
To persons in foreign countries	114
To Indiana periodicals	654
To outside periodicals	92
Total	15,324

I herewith submit in connection with the preceding report, brief statements of the work of the several departments of the Station, as transmitted to me by the heads of the departments.

Respectfully submitted,

C. S. PLUMB,
Director.

REPORT OF THE AGRICULTURAL DEPARTMENT.

To C. S. Plumb, Director:

Sir—The following is a brief outline of the work of the Agricultural Department for the six months ending June 30, 1898:

1. *Test of Varieties.* Thirty-one varieties of wheat, thirteen of oats, three of kaffir corn, eight of soy beans, four of cowpeas, six of sorghum, one of vetch, two of sunflowers, three of clover, one each of brome grass, sweet corn and spring rye. Idaho and Russian wax field peas, and alfalfa, from home-grown and imported seed, are also under trial.

Several varieties of wheat sent out by the Department of Agriculture are under trial here for the first time, and most of them are apparent failures. Several new varieties of oats are also under trial. The purpose is to limit the tests of wheat and oats largely to the new kinds that the Station may be able to advise the farmers of their relative merits as compared with standard varieties.

Several kinds of forage plants comparatively new to this section are under trial. The experiments with forage crops are being conducted on a larger and more comprehensive scale than heretofore.

2. Test of methods of culture, with reference to effect on yield of crop and on conservation of soil moisture.

3. Test of early and late planting of corn.

4. Test of thick and thin planting of corn.

5. Test of deep and shallow culture of corn.

6. Test of planting corn in furrow and on the level.

7. Test of corn cultural implements.

8. Test of fertilizer upon wheat when applied as a top dressing, and also when drilled in with the seed.

9. Tests of commercial fertilizers and fresh horse manure in wheat, oats and corn.

10. Test of the lasting effect of horse manure on yield of corn.

11. Test of turning under a green manure (rye or crimson clover, cornstalks or straw), as means of renewing the soil in continuous corn culture.

12. Test of sowing clovers at intervals during the growing season.

13. Test of sowing wheat in drills six and eight inches apart respectively.

Most of the experiments above named have been in progress several years.

The past winter was quite severe upon wheat, much of which was put in late last fall owing to drouth at that time.

The wheat that was sown after rain fell, early in October, is better than that sown earlier.

Owing to the late start and the rather severe winter the stand of wheat is rather thin. The wheat blades are considerably rusted, but the stems appear to be quite free. The wheat is slightly infested with the green aphis and there is an unusual amount of wheat scab. The standard and acclimated varieties are but slightly affected, but over 50 per cent. of the heads of some of the newer varieties are affected. The varieties most injured by wheat scab are White Golden Cross, Pedigree Giant, Diamond Grit, Gold Coin and Oakta Chief. As a rule the wheat pests have made their attacks too late to do very serious damage. The wheat crop which is now being harvested, appears to be of good quality and promises more than an average yield.

Although frequent heavy rains in May delayed planting, the spring crops are at this writing (June 29th) in good condition.

The oat crop promises well, although it shows an unusual amount of smut.

Owing to delay in planting, much of the corn is very backward. It will therefore be liable to suffer in case of drouth or early autumn frosts.

W. C. LATTA,
Agriculturist.

June 29, 1898.

REPORT OF THE HORTICULTURAL DEPARTMENT.

Professor C. S. Plumb, Director:

Sir—The following is a brief report of the work of the Horticultural Department for the past six months:

The three experiments which have been running all winter in the greenhouse are: (1) Sub vs. surface irrigation for lettuce; (2) sub-irrigation for lettuce, (a) with soft bricks in the bottom of the bed for the purpose of evenly distributing the water over the entire bed; (b) with two rows of two-and-a-half-inch tile running the entire length of the bed and across one end, filling in water from one end; (3) sub vs. surface irrigation for tomatoes in (1), one bed four feet four inches by twenty-five feet, was lined with zinc and arranged as described in (a) above, leaving a space for soil above the bricks of five inches. The water was all applied by means of a tube to the bottom of the bed and was fed to the plants by capillary attraction. The other bed of the same dimensions was five inches deep, filled with soil and watered entirely upon the surface. The results obtained are very much in favor of the subirrigation, both as to weight of crop and time of maturing. In (2) the results are in favor of the soft bricks as a base for subirrigation bed, although the first cost of arranging the bed with tile was only about one-seventh that of brick. In (3) the results are decidedly in favor of sub-irrigation, as the following figures will show: Two varieties were used in the experiment, viz.: Lorillard and Stone. The first variety is the one generally used for forcing, but my experiments showed very clearly that the Stone is in all respects equal to it as a forcing variety, especially when sub-irrigation is used.

Following are the comparative yields of fruit of the sub and surface irrigated plants:

LORILLARD.

Surface irrigation	111 fruits, average weight 1.84 oz.
Sub-irrigation	103 fruits, average weight 4.7 oz.

STONE.

Surface irrigation	64 fruits, average weight 2.47 oz.
Sub-irrigation	94 fruits, average weight 4.23 oz.

As will be seen the Lorillard fruits averaged 2.22 oz. in favor of the sub-irrigation, while the Stone averaged 1.76 oz. in favor of the same method. While Lorillard yielded a few more fruits than Stone, there were more of them too small for marketable purposes.

The experiments in spraying consist in the use of arsenites, whale-oil soap, chloronaptholeum and Bordeaux mixture. Varietal tests of fruit and vegetables are being continued.

JAMES TROOP,
Horticulturist.

July 1, 1898.

REPORT OF THE CHEMICAL DEPARTMENT.

Professor C. S. Plumb, Director:

Sir—The attention of the Chemical Department has been chiefly occupied during the past six months with the matter of testing the sugar beet question in Indiana. A considerable number of Sugar Beet Associations have been formed and we have aimed to secure their co-operation. Some of these associations have distributed seed and we have sent out 768 samples from the Station. The purpose has been to secure field conditions for the beets, and for this reason larger quantities of seed have been sent out to each party than is usually used in seed distribution.

During the month of January an investigation of buckwheat was begun. This plant is structurally in an intermediate position between the grasses and the legumes. The work was not quite finished when Mr. Barrett resigned as Assistant Chemist at the end of January.

Miscellaneous work including an examination of marls, crematory ash and minerals has been conducted as circumstances permitted.

The interest of the people in sugar beet work was so great that I thought it best to give personal attention to every detail of the work rather than assign it to a clerk. The absence of an Assistant Chemist from February to July has reduced the amount of analytical work to be reported upon.

Mr. A. H. Bryan went on duty as Assistant Chemist July 1st, and began work on feeding material.

Very respectfully,

H. A. HUSTON,
Chemist.

July 8, 1898.

REPORT OF THE BOTANICAL DEPARTMENT.

To C. S. Plumb, Director:

Sir—The work of the Botanical Department of the Station for the six months ending June 30, 1898, was in brief as follows:

Lettuce was grown in the greenhouse upon a sub-watered bench divided into seven sections, five of which were severally treated with different combinations of chemical fertilizers and two left untreated as controls. Similar studies have been made with lettuce in cans under vegetation-house conditions. Fine growth was secured in both cases and the knowledge of the subject as presented in Bulletin No. 66, printed in October, 1897, has been considerably extended.

A crop of dwarf peas replaced the lettuce in the greenhouse, and was harvested in June. The problem in this case was in regard to the influence that the size of seed exerts upon subsequent generations. The same problem is also being studied by growing beans in sub-watered beds upon trucks as part of the vegetation-house work. Six trucks are employed.

The work upon the questions in connection with use of chemical fertilizers in growing roses is being continued in lines similar to the studies of last year.

Some work upon growing mushrooms in an outdoor cellar has given only partial success.

Attention has been given to the occurrence of plum pockets and peach curl, diseases which have been especially prevalent during the past growing season, and a newspaper bulletin, No. 60, was issued for the information of the public.

More attention than usual has been directed to the cereal rusts. The rust on oats has been definitely connected with a form apparently quite dissimilar, not infrequent on the wild buckthorn (*Rhamnus lanceolata*), a shrub in woodlands that attracts little attention. Sowings of the spores of the buckthorn rust were made

on oats in the greenhouse during June, and the typical oat rust appeared upon the leaves in eight days.

Some attention has been given to a hardy evergreen bedding plant, blooming in May, a native of Indiana, but not before brought into cultivation.

Respectfully submitted,

J. C. ARTHUR,
Botanist.

July 5, 1898.

REPORT OF THE VETERINARY DEPARTMENT.

To C. S. Plumb, Director:

Sir—Since submitting a report of the Veterinary Department December 31, 1897, the work has been almost wholly confined to a study of the embryology, anatomy and physiology of the mammary gland. The results are to be published in a bulletin in the near future, and hence a summary will not be required at this time.

The Department has several lines of work under observation—the treatment of contagious abortion among cows, tuberculosis, hog cholera and stable hygiene, but the results are not ready for publication.

A bulletin upon "The Relation of Water Supply to Animal Diseases" was submitted in May.

Respectfully yours,

A. W. BITTING,
Veterinarian.

TREASURER'S REPORT, EXPERIMENT STATION.

As Treasurer of Purdue University, I hereby submit my report of all moneys received during the year ending June 30, 1898, on account of Experiment Station funds:

From U. S. Government	$15,000 00
From farm receipts	1,709 13
Total	$16,709 13

JAMES M. FOWLER,
Treasurer Purdue University.

FINANCIAL STATEMENT.

The Agricultural Experiment Station of Indiana, in account with the United States, for the year ending June 30th, 1898:

DEBIT.		
Received of the Treasurer of the United States, receipts as shown by the Treasurer's report		$15,000 000
CREDIT.		
Salaries	$8,871 83	
Labor	3,082 82	
Publications	618 14	
Postage and stationery	120 37	
Freight and express	102 41	
Heat, light and water	303 21	
Chemical supplies	214 97	
Seeds, plants and sundry supplies	572 85	
Fertilizers	30 31	
Feeding stuffs	167 57	
Library	128 37	
Tools, implements and machinery	234 83	
Furniture and fixtures	47 05	
Scientific apparatus	88 47	
Live stock	186 35	
Traveling expenses	43 55	
Contingent expenses	7 22	
Building and repairs	179 68	
Total	$15,000 00	$15,000 00

I hereby certify that the above is a correct statement of expenditures in Station Fund for year ending June 30, 1898.

E. A. ELLSWORTH,
Secretary Board of Trustees.

IMPROVEMENT FUND EXPERIMENT FARM FOR YEAR ENDING JUNE 30, 1898.

DEBIT.

Balance June 30, 1897................		$79 98
Receipts from farm for 1898..........		1,709 13

CREDIT.

Salaries	$300 47	
Labor	230 00	
Heat, light and water................	58 20	
Seeds, plants and sundry supplies.......	11 43	
Furniture and fixtures...............	115 50	
Contingent expenses	99 60	
Balance	973 91	
Total	$1,789 11	$1,789 11

I hereby certify that the above is a correct statement of expenditures from Improvement Fund for year ending June 30, 1898.

E. A. ELLSWORTH,
Secretary Board of Trustees.

PURDUE UNIVERSITY,

Twelfth Annual Report

of the

Indiana Agricultural Experiment Station

LAFAYETTE, INDIANA.

For the year ending June 30, 1899.

PRESS OF
HOME JOURNAL COMPANY
LAFAYETTE IND.
1900.

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STATON STAFF.

JAMES H. SMART, LL. D.,
President of the University

Charles S. Plumb, B. S............................Director.
William C. Latta, M. S.......................Agriculturist.
James Troop, M. S.............................Horticulturist.
Henry A. Huston, A. M., A. C.....................Chemist
Joseph C. Arthur, D. Sc..........................Botanist.
Arvill W. Bitting, D. V. M....................Veterinarian.
William Stuart, M. S....................Assistant Botanist.
William B. Anderson, B. S.**..........Assistant Agriculturist.
James Harrison Skinner, B. S..........Assistant Agriculturist.
A. Hugh Bryan, B. S.....................Assistant Chemist.
H. E. Van Norman, B. S..........Farm Supt. and Assistant.

*Died Feb. 20, 1899.

**Resigned March 20, 1899.

TWELFTH ANNUAL REPORT

OF THE

Purdue University Agricultural Experiment Station

REPORT OF THE DIRECTOR

To President James H. Smart:

Sir:—The following report is for the year ending June 30, 1899, and is the first annual report of this Station covering the year ending June 30, instead of the regular calendar year as heretofore. This change has been made at the request of the United States Department of Agriculture, in order that the report might be published at an early enough date to enable Department officials to use it along with those of other Stations in making up reports for Congress on Station administration.

This report also differs from its predecessors in containing comprehensive reports on experiments from the different departments of the Station, instead of consisting of brief reports of work in progress, as has heretofore been the case. The policy now being adopted, is to publish bulletins of rather limited length from time to time, and use the annual report as a medium for publishing more fully than heretofore, the results of research work. This plan will greatly enlarge the annual report, but it is believed will also add materially to its value to the farmers of the state. Heretofore, but 500 or 1,000 copies of the report have been printed, and these distributed to Experiment Stations and applicants. I now suggest that at least 5,000 copies of this report be printed, so that copies may be distributed to such farmers as may apply for them.

The experimental work for the year has progressed uniformly and smoothly. The sugar beet investigations have continued as heretofore, and over 1200 pounds of seed supplied by the United States Department of Agriculture have been distributed to 550 farmers in this State. Although the sugar beet investigations of the Station now date back for over 10 years, still much interest is shown in the work by the people. This season in addition to the regular testing work, experiments have been undertaken to show the effects of different artificial plant foods on sugar production in the root.

The investigations of the Station on surface vs. sub-irrigation have attracted considerable attention, especially as relates to lettuce culture. A number of different kinds of plants, however, are receiving the attention of the botanical department in this connection, and more information on the subject is printed elsewhere in this report.

Some years ago investigations were undertaken by the Chemical department, on the composition of edible fungi, while the Botanical department investigated the botanical side of the subject, and latterly the cultural phase of it. At the present time a small mushroom house is in operation, in which last year a crop of about 100 pounds of mushrooms was harvested. This work now in hand and contemplated promises most interesting results from an economic standpoint.

No extended investigation work has been conducted during the year in the Veterinary Department, owing to the absence on leave for a considerable part of this time of Dr. Bitting, Station Veterinarian, who has been pursuing special studies at Indianapolis.

The general work of the Station has continued along essentially the same lines as during the past few years, no changes of importance having taken place.

The Station Staff has undergone but slight change during the year, and this only in the resignation of Mr. W. B. Anderson, the Assistant Agriculturist, who retired to his farm in the southern part of the State. Mr. J. H. Skinner, B. S., a graduate of the School of Agriculture at Purdue, has become Mr. Anderson's successor.

Improvements of a much needed character have been effected on the farm this year. The erection of a new piggery for experimental feeding, which was completed in June, was the most important improvement in the working equipment on the farm, that has thus far taken place in years. We now have a modern two

story pig feeding building, constructed with a view to securing the most sanitary arrangements, and a structure that will greatly facilitate the care and feeding of our swine. This building is illustrated and described elsewhere in this report.

The basement of the horse barn has been remodelled, and a number of commodious box stalls constructed in place of the old fashioned open stalls on the north side of the basement. A new harness room has also been built, and the stairway leading to the floor above has been changed to a more suitable location against the west side of the basement, thereby economizing room.

Another important improvement was made in building an addition to the west side of the Tool House. This is 56 feet long and 18 feet wide, and is so constructed that the entire west side consists of a series of large doors hung with rollers on two tracks. At any point on the side of the building tools can be taken in or out by simply pushing a door to one side. This system is an admirable one, and is such as may be adopted to advantage by visitors to the Station, seeking for improved methods of housing tools.

Publications have been issued as follows during the past year.

PAMPHLET BULLETINS.

Bulletin No. 72. vol. IX, August ,1898, pp. 67-76. Field experiments with wheat. By W. C. Latta and W. B. Anderson.

Bulletin No. 73. vol. IX, October, 1898. pp. 77-92, figs. 17-19. Tests of strawberries, raspberries, blackberries and grapes. By James Troop.

Bulletin No. 74. vol. IX, November. 1898, pp. 93-100, fig. 20, plates VI. A native white bedding plant. By J. C. Arthur.

Bulletin No. 75. vol. X. January, 1899, pp. 20, fig. 1. The sugar beet in Indiana in 1898. By H. A. Huston and A. H. Bryan.

Bulletin No. 76. vol. X, March, 1899, pp. 21-28. Skim milk as a food for young growing chickens. By W. B. Anderson.

Bulletin No. 77, vol. X, March, 1899. pp. 29-44, Field experiments with corn. By W. C. Latta and W. B. Anderson; Mangel wurzels and the cost of production. By H. E. VanNorman; Formalin for grain and potatoes. By J. C. Arthur.

Bulletin No. 78, vol. X, May, 1899, pp. 45-52, figs. 2-4. The San Jose scale and oher scale insects, and the Indiana nursery inspection law. By James Troop.

NEWSPAPER BULLETINS.

No. 62, July 12, 1898. Scab in heads of wheat. By J. C. Arthur, Botanist.

No. 63. July 28, 1898. Varieties of winter wheat. By W. C. Latta, Agriculturist.

No. 64, August 5, 1898. Contagious sore eyes among cattle. By A. W. Bitting, Veterinarian.

No. 65, August 6, 1898. Loose smut of wheat. By William Stuart, Assistant Botanist.

No. 66, August 10, 1898. Disinfecting pens at fairs. By A. W. Bitting, Veterinarian.

No. 67, August 26, 1898. Sugar beets: Prevention of leaf injury—Harvesting. By H. A. Huston, Chemist.

No. 67, September 26, 1898. Sore mouth among cattle. By A. W. Bitting, Veterinarian.

No. 68, October 3, 1898. The grain weevil. By James Troop, Horticulturist.

No. 69, November 2, 1898. Bacterial rot of cabbage. By William Stuart, Assistant Botanist.

No. 70, December 10, 1898. The cost of creamery buildings and outfits. By C. S. Plumb, Director.

No. 71, January 3, 1899. Live stock diseases in Indiana during 1898. By A. W. Bitting, Veterinarian.

No. 72, March 25, 1899. Sugar beet seed. By H. A. Huston, Chemist.

No. 73, April 19, 1899. The soy bean as a farm crop. By W. C. Latta, Agriculturist.

No. 74, May 13, 1899. Points concerning the nursery inspection law. By James Troop, Horticulturist.

No. 75, May 31, 1899. Black leg or black quarter. By A. W. Bitting, Veterinarian.

No. 76, June 24, 1899. The use of cyclone churns. By C. S. Plumb, Director.

The demand for the Station bulletins has become very great. The following table gives the number of copies of each report and bulletin published, number of pages per copy and total pages per edition.

No. of publication.	No. copies printed.	Pages in one copy.	Total pages in entire edition.
10th report	500	67	33,500
11th report	500	22	11,000
Bull. 72	17,000	10	170,000
Bull. 73	16,000	16	256,000
Bull. 74	16,000	8	128,000
Bull. 75	16,000	20	320,000
Bull. 76	18,000	8	144,000
Bull. 77	18,000	16	288,000
Bull. 78	18,000	8	144,000
16 newspaper bulletins	11,200	1	11,200
Total	131,200		1,505,700

This table shows that the Station published over a million and a half pages of reading matter during the past year. The extent to which much of this was read, is not easy to comprehend. The newspaper bulletins are mailed to 650 different periodicals, in which they are extensively published, so that it can readily be

seen that they are brought to the attention of millions of readers in the central west. These with the 130,000 copies of the pamphlet bulletins, provide a wide distribution of station literature over a wide territory.

Mailing list. How extensively the bulletins are circulated may be seen from the following statement of the nature of our mailing list, which on June 30, comprised 16,512 names. This table shows the growth of the list from 1893 to June 30, 1899

STATION MAILING LIST.

Number of names on list of	Jan 18, 1893.	Jan 4. 1894.	Jan.10, 1895.	Jan. 1, 1896.	Jan. 1, 1897.	Jan. 1, 1898.	June 30 1899.
People in Indiana.......	5,741	7,131	8,666	9,143	10,590	11,900	13,458
Indiana periodicals......	635	668	653	625	660	650	636
People in other States...	1,158	1,316	1,606	1,788	1,872	2,000	2,200
Period'als in other State.	83	91	86	92	76	80	96
Foreigners	26	51	61	77	91	105	112
Foreign periodicals......	7	7	7	6	8	8	10
Total	7,650	9,264	11,079	11,731	13,297	14,750	16,512

I herewith submit, as a part of the annual report of the Station, a series of contributions from the different departments reporting upon the work in progress or completed.

Respectfully submitted,

C. S. PLUMB, Director.

ROSE GROWING WITH CHEMICAL FERTILIZERS.

By William Stuart.

At the present time the importance of the rose growing industry can hardly be estimated. The winter forcing of roses in America alone has assumed such proportions and represents such an outlay of capital, that any knowledge conducive to a better understanding of the food requirements of the plants, gives to the industry an additional value.

A frequent complaint made from time to time by rose growers [1] is that injurious effects result from the use of acidulated bone meal when applied to the soil in the rose bench. According to these complaints injury may result from an application to the soil previous to setting the plants or from a surface dressing afterwards. Whether or not the injury is a result of the acidulated bone meal or to some adulterant which it contains is not definitely known. Chemists affirm that acid dissolved bone meal rarely if ever contains any appreciable amount of free acid, certainly never in sufficient amounts to do injury. There is good reason for believing that much of the injury is a result of improper feeding, or cultural attention, rather than of the presence of free acid in the bone meal. Such a quality of bone meal was used in connection with the other tests upon roses, and the results are given in the following pages.

In view of the commercial value of the rose and its ever increasing popularity with the masses, as well as the lack of positive knowledge regarding the relative effects of different chemicals upon its growth, it was thought advisable by the botanical department of this Station to undertake some experiments with roses. These experiments undertaken by the writer, under the supervision of Dr. J. C. Arthur, Station Botanist, were intended to show the relative effects of different forms of phosphoric acid, both separately and conjointly with nitrate of soda and muriate of potash, in the growing of roses.

It is apparent to all that the value of an experiment is increased by the uniformity of the conditions to which all the plants are subjected. The nature of the experiment about to be outlined, precluded the possibility of its being conducted according to the methods usually followed by florists, involving as it did, so many different combinations of fertilizers. The method adopted, while not in anywise adapted to commercial practice, yet will, I think, show that all plants were accorded the same

[1] *Am. Florist*, 6 : 282, 1890; 12 : 414, 1896. *Florists' Exchange*, 8 : 981, 1896; 9: 73, 1897.

treatment, and that any variation in the product was due to the fertilizers applied. In the application of the fertilizers to the plants different amounts were used in order to determine how much the plant could most profitably use. The value of the experiment to the florist depends not so much upon the fact that by the use of chemical fertilizers, roses can be grown without the aid of barnyard manure, but rather that good results may be obtained if the right fertilizers are used. If it can be determined by these results that more roses can be produced when a particular form of phosphoric acid is used, and that by combining this with some form of nitrogen or potash or both, a greater increase may be obtained, then it would seem that at least a step forward has been made toward a better knowledge of the actual food requirements of the rose. If it can be proven that a sufficient amount of phosphoric acid can be added to the soil at the outset to supply the plants every need for the whole season, then we may save ourselves the labor and expense of frequent applications of that ingredient.

As no suitable greenhouse structure was available for the experiment, it was decided to make use of the vegetation house[2] and to conduct the experiments during the summer months.

Selection of plants. In order to make the comparative results of as much value as possible, it was deemed best to confine our attention to a few varieties. It became necessary then to select such plants as would prove good summer bloomers. The Kaiserin Augusta Victoria and the Perle des Jardins were accordingly decided upon as being well adapted for the purpose. The former is a hybrid tea, introduction of 1891 by Lambert and Reiter. Its parentage, so far as known to the writer, has never been given by its introducers, and is possibly unknown to them. It is recognized as one of the best white summer blooming roses grown. The Perle des Jardins is a yellow tea rose, introduced by N. Levet in 1873,[3] and is generally conceded as being one of the best yellow outdoor roses grown.

Plants of the above mentioned varieties from three inch pots were obtained from E. G. Hill, of Richmond, Ind., May 14, 1896. A sufficient number of plants were ordered to permit of some selection.

[2] The vegetation house is a glass building, especially constructed for conducting experiments during the summer months, having no provision for artificial heating, being intended simply as a protection for the plants during storms.

[3] *Gard. Chronicle*, *5*, new series, p. 755, 1876.

Soil. It is generally conceded that a clayey soil is best adapted to the growth of roses, hence that selected for the experiment was one which contained a good percentage of clay. It was necessary also to select a soil which was reasonably exhausted of plant food, or had never accumulated it, this being secured by the removal of the upper three inches of soil and then taking out to a depth of 12 inches or more. In order to make it all of a uniform character, it was passed through an eighth inch wire mesh screen, and afterwards thoroughly mixed by shoveling it over two or three times.

Pots. The pots used for growing the roses were of zinc, especially constructed for experimental work. They are water tight and so arranged as to permit of sub-watering. This is accomplished by the side of the pot being perforated with a half inch hole near the bottom. A zinc cup attached to the outer surface of the pot surrounds the hole and thus prevents any loss of water while watering, the water being run into the hole by means of a glass funnel, to which is attached a piece of rubber tubing. To prevent the soil from obstructing the entrance of the water to the pot, an inverted shaped trough of zinc was laid on the bottom of the pot, from the hole to the opposite side. The lower sides of this piece of zinc were notched in order to permit the water to distribute itself rapidly through the surrounding material.

The method of filling the pots was similar to that followed in previous cereal experiments. A weighed quantity of clean, medium coarse gravel, was first put in the pots, the gravel being used to afford good drainage as well as to facilitate the distribution of the water. It was then filled with a weighed quantity of soil. The pots were then placed on iron bases resting on movable trucks. These bases are raised by means of short legs, about ¾ inch above the surface of the truck. An outer cylinder of tin having a diameter of about one and one-half inch greater than that of the pot, was then placed over the can, being supported by its lower surface on three projections of the base. In this way a free circulation of air around the pot was obtained, as well as protection of the pot from the direct rays of the sun.

Fertilizers. The fertilizers were applied to the soil in the cans, previous to setting the plants therein, and were thoroughly incorporated with it. The kinds of fertilizers used were as follows: *Dissolved bone black, rock phosphate, raw bone meal, acidulated ground bone, superphosphate, nitrate of soda and muriate of potash.*

The amounts applied to each plant were, in the case of the nitrate of soda and muriate of potash, in part based on some previous work on cereals, while that of the phosphoric acid was based on the assumption that one-half gram of phosphoric acid was sufficient for each 100 grams of water free substance of the plant, a plant being assumed to produce on an average 290 grams of waterfree substance. Only the available phosphoric acid was taken into account in the computations.

The available amounts of phosphoric acid as shown by analysis, in the ingredients used, are as follows:

Dissolved bone black	=16 %	phosphoric acid	0.60% nitrogen.	
Rock phosphate	=12.74%	"		
Raw bone meal	= 5.81%	"	4.27% "	
Acidulated ground bone*	= 7.91%	"	2.28% "	1.62% potash.
Superphosphate	=14.22%	"		

[*]. The writer is indebted to Mr. W. J. Jones, Assistant State Chemist, for the analysis of the acidulated ground bone.

In addition to the phosphoric acid, nitrogen and potash already given for the acidulated ground bone, tests for chlorides and sulfates were obtained. The amount of chlorine present was largely in excess of that required for the potash contained, the excess being equal to over 166 lbs., or an amount equal to 274 lbs. of salt per ton.

It is apparent from the above results that the acidulated ground bone was greatly adulterated with common salt. The manufacturers of this ground bone are unfortunately not known to the writer, the sample having been obtained from a LaFayette florist, who in turn had purchased it from a dealer in florists' supplies in Cincinnati, Ohio.

Grouping of fertilizers. As the number of zinc pots of the smaller size was limited to 80, and the available ones of the next size larger to 42, it became necessary to so group the plants and fertilizers as to permit of as many duplicate series as safety would permit.

The Kaiserin roses being deemed best adapted to the work intended, they were planted in the smaller pots. This gave 80 plants which were divided into four groups of 20 each, and numbered from I—IV. The surface area of the smaller pots was approximately 48.7 inches and of the size larger 75.6 inches.

Each group contained a different form of phosphoric acid, and was so arranged as to be in exact duplicate, in so far as the available phosphoric acid was concerned. In tables I—IV are presented groups I—IV, giving the kinds and amounts of fertilizers applied, together with the actual amounts contained in each ingredients.

TABLE I. GROUP I.

Kind of fertilizer and amount applied.

No of plant	Dis. bone black, in grams.	Muriate of potash, in grams	Nitrate of soda in grams	Rate per square yard in ounces.		
				Dis bone black	Muriate of potash.	Nitrate of soda
1, 2	....	....	....	....	....	....
3, 4	.545	....	....	.51	....	....
5, 6	2.728	....	....	2.6	....	....
7, 8	13.640	....	....	12.8	....	....
9, 10	2.728	....	3.145	....	....	2.95
11, 12	2.728	....	6.290	....	....	5.90
13, 14	2.728	4.194	....	....	3.93	....
15, 16	2.728	8.387	....	....	7.87	....
17, 18	2.728	4.194	3.145	....	....	....
19, 20	13.640	8.387	6.290			

TABLE II. GROUP II.

Kind of fertilizer and amount applied.

No. of plant.	Rock phosphate, in grams.	Muriate of potash, in grams	Nitrate of soda, in grams	Rate per square yard in ounces.		
				Rock phosphate.	Muriate of potash.	Nitrate of soda.
21, 22	....	....	....	....	....	....
23, 24	.685	....	....	.64	....	....
25, 26	3.426	....	....	3.22	....	....
27, 28	17.130	....	....	16.10	....	....
29, 30	3.426	....	3.145	....	....	2.95
31, 32	3.426	....	6.290	....	....	5.90
33, 34	3.426	4.194	....	....	3.93	....
35, 36	3.426	8.387	....	....	7.87	....
37, 38	3.426	4.194	3.145	....	....	....
39, 40	17.130	8.387	6.290	....	....	....

TABLE III. GROUP III.

Kind of fertilizer and amount applied.

No of plant	Raw bone-mea. in grams.	Muriate of potash. in grams	Nitrate of soda. in grams	Rate per square yard in ounces		
				Raw bone-meal.	Muriate of potash.	Nitrate of Soda.
41. 42	....	....	....	....	....	....
43. 44	1.043	....	....	1.54	....	....
45. 46	8.219	....	....	7.71	....	....
47. 48	41.095	....	....	38.55	....	....
73. 74	8.219	....	3.145	....	....	2.95
75, 76	8.219	....	6.290	....	....	5.90
77. 78	8.219	4.194	....	....	3.93	....
79. 80	8.219	8.387	....	....	7.87	....
81. 82	8.219	4.194	3.145	....	....	....
83. 84	41,095	8.387	6.290	....	....	....

TABLE IV. GROUP IV,

Kind of fertilizer and amount applied.

No. of plant.	Super-phos-phate, in grams.	Muriate of potash, in grams	Nitrate of soda, in grams	Rate per square yard in ounces.		
				Super-phos phate.	Muriate of potash.	Nitrate of soda
85, 86	....	....	....	....	....	....
87, 88	.613	....	....	.58	....	....
89, 90	3.068	....	....	2.88	....	....
91, 92	15.340	....	....	14.40	....	....
144, 145	3.068	....	3.145	....	....	2.95
146, 147	3.068	....	6.290	....	....	5.90
148, 149	3.068	4.194	....	....	3.93	....
150, 151	3.068	8.387	....	....	7.87	....
152, 153	3.068	4.194	3.145	....	....	....
154. 155	15.340	8.387	6.290	....	....	....

The muriate of potash used contained 53 per cent. of potash, while the nitrate of soda contained 16 per cent of nitrogen.

In making the original computations, no allowance was made for the nitrogen in the dissolved bone black and raw bone meal, hence groups I and III are unfortunately not exact duplicates of II and IV, in so far as their nitrogen supply is concerned.

The arrangement of the Perle des Jardins was somewhat different from that of the Kaiserin. In the first place, the pots in which they were grown were considerably larger, consequently more soil was used in filling them; 25 instead of 15 pounds being used. In every other respect the work was performed in the same manner as with the former plants. Like them they were divided into four groups, of which the first or group V was an exact duplicate of group I, at least in so far as the chemical fertilizers are concerned. Group VI contained 12 plants, of which all received dissolved bone black in varying amounts, and half of them an occasional watering with liquid manure. Group VII included four plants, having for their phosphoric acid supply some acidulated ground bone, which the writer obtained from a florist, who said that it had proved injurious to his roses. In group VIII, which included six plants, a black loam from the garden was used in filling four of the pots, instead of the clay soil; the remaining two pots being filled with a potting soil, consisting of rotted sods, to which had been added one-fifth its bulk of rotted manure. The actual amounts of fertilizers applied to the different groups just mentioned are presented in tables V-VII. As that of group V is an exact duplicate of I, it is omitted in the present set of tables.

TABLE V. GROUP VI.

Kind of fertilizer and amount applied. Rate per sq. yd. in ozs.

No of plant.	Diss. bone-black, in grams	Muriate of potash in grams	Nitrate of soda, in grams	Liquid manure	Dissolved boneblack
118, 119	2.728	none	none	none	1.65
126, 127	2.728	none	none	L. manure	1.65
129, 130	6.820	none	none	none	4 12
131, 132	6.820	none	none	L. manure	4.12
134, 137	13.640	none	none	none	8 24
138, 139	13.640	none	none	L manure	8.24

The application of the same relative amount of available phosphoric acid, together with the same amount of potash, and with the exception of the nitrogen contained in the phosphoric acid supply of I and III, of nitrogen in each of the first four

groups, afforded an opportunity for a comparative study of the effects of different forms of phosphoric acid upon the growth of the plants and the production of flowers.

The pots containing the plants being on movable wooden trucks, were run in under shelter every night and during storms; at other times they were in the open air. All water was supplied

TABLE VI. GROUP VII.

Kind of fertilizer and amount applied.

No. of plant	Acidulated ground bone, in grams	Muriate of potash in grams	Nitrate of soda. in grams	Rate per squard yard per oz.		
				Acidulated ground bone	Muriate potash	Nitrate soda
140,141	6.820	4.194	none	4.12	3.93	....
142,143	13.640	4.194	none	8.24	3.93	....

TABLE VII. GROUP VIII.

No of plant	Dissolved boneblack in grams	Muriate of potash, in grams	Kind of soil	Rate per sq. yd. in ozs.	
				Dissolved boneblack	Muriate of potash
61,108	....	....	black loam	....	....
111,128	2.728	4.194	" "	1.65	3.93
133,135	....	....	potting soil	....	....

the plants from below. Throughout the experiment a careful record was kept of the number of blooms cut from each plant. This included the quality of the rose, the number of nodes removed, the length of the stem, color of foliage, etc. Each flower stem was cut back to about two eyes in order to place all under the same conditions. At the close of the season of 1896, a series of photographs were taken in order to show what effect the several fertilizers had upon the growth of the plants. Plate I-A shows a plant from each of the four groups receiving a medium supply of phosphoric acid, together with a plant which had not received any. Plant I represents the control plant, 6 dissolved bone black, 25 rock phosphate, 45 raw bone meal, 89 superphosphate. Apparently, 89 is the largest plant, with 6 a very close second, and 45, 25 and 1 following in the order mentioned.

In plate I-B are shown four plants from group III, in which are contrasted plants receiving minimum, medium and maximum amounts of phosphoric acid, with plant 42, which did not receive

any. A cursory glance at the plate will show at once that the development of the plants has been in accordance with the amount of fertilizers applied.

In order to compare the effects of nitrate of soda and muriate of potash when used separately, as well as conjointly, in connection with phosphoric acid as against phosphoric acid alone, and one without fertilizers, a third photograph was taken (plate II-A). It will be observed that all except 42 received medium amounts of the fertilizers. There seems to be very little difference between 77 and 81, the former of which received raw bone meal and muriate of potash, while the latter received nitrate of soda in addition to these two. A similar state of affairs seems to exist between 45 and 73, to the first of which raw bone meal was applied, while the latter received raw bone meal and nitrate of soda.

Having considered some of the effects of different chemical combinations on the growth of the Kaiserin roses, it is but fitting that a few of the Perles should be represented, in order to compare the relative growths made by the two varieties under identically the same conditions. In plate II-B, we have a plant each in clay and black loam, also one each of plants receiving dissolved bone black and muriate of potash. Nos. 136 and 61 represent the clay and black loam soils, respectively, while 109 and 128 are those having the above mentioned fertilizers, 109 being in clay. In this case there is no difficulty in discerning the difference in the size of the plants. In each instance those grown in the black loam are much larger and sturdier plants. A comparison of plant 136 with that of 1, in plate I, which are comparable plants, shows a noticeable difference in favor of the latter. With few exceptions, this difference was noticeable throughout the series of experiments. As has been noted in plate IV, the growth of the plants in the black loam was much superior to those in clay soil, when grown under exactly the same conditions. Both soils were considered deficient in plant food, hence there could have been but little influence exerted in this direction. In only one respect did the treatment accorded the plants vary from that usually given; this was in the application of water. Possibly sub-watering gives better results on light than on heavy soils, on account of its less retentive qualities, thereby permitting a freer movement of water through the soil.

Wintering plants. Being desirous of continuing the experiment another season, it became necessary, in the absence of any artificial heat in the "Vegetation House," as well as facilities for proper ventilation, to provide some means by which the plants

could be carried through the winter without injury from heat or frost. A cheap and efficient means of accomplishing this end, was effected in the construction of a pit in which some unused hotbed sashes were made to do service as a portion of the roof. In the construction of the pit, comparatively little excavating was done, only about 18 inches being removed from the whole surface, and an additional 18 inches on the south side for a walk. In size it was 9x15 feet, running east and west. The north wall being raised about a foot above the surface of the ground, while the south wall was raised two feet. It was built with a hip roof, the north roof being formed of five hot bed sashes, while that of the south was covered with boards and then banked with straw and earth. The sash was given a north exposure in order that the rays of the sun in the early spring would have little effect on the inside temperature of the pit, thus permitting the plants to be kept dormant much later than could otherwise have been done. An entrance to the pit was made at the east end, opening directly into the walk. The plants were stored in the pit November 25, 1896, having been previously well ripened off.

All the attention given the plants during the winter months consisted in protecting the glass during the severe weather with coarse litter, and admitting light and air whenever possible. No water being given the plants from the time they were placed in the pit till they were pruned, March 29, 1897.

Pruning. As soon as the buds began to push out in the spring, the plants were closely pruned, each branch being cut back to two eyes on both the Kaiserin and Perle roses. Many of the plants had retained quite a large number of their old leaves throughout the winter. On April 1st, the plants were removed from the pit to the vegetation house. To avoid introducing any disturbing factors, it was decided, with the exception of group VIII, not to repot the plants, but to apply the same amount of fertilizers as during the first season, to the surface of the soil, and stir it in as deeply as possible without injuring the newly forming roots. The fertilizers were applied April 2-5. The plants in group VIII were removed from the pots, the soil shaken off and then repotted in black loam. The following amount of raw bone meal was added:

TABLE VIII. GROUP VIII.

Kind of fertilizer and amount applied.

No of plant	Raw bonemeal, in grams	Rate per square yard in ounces
61, 108		
111, 128	41.095	38.55
133, 135	61.643	57.83

Injury from fertilizers. As the plants began to send out new shoots, it was quite noticeable that those having a large supply of potash or nitrate of soda, or both, started much more slowly, and even in some cases the young leaves were badly burned. With one exception, all recovered from the effects of this injury, though rather slowly. To show that the injury was due to the nitrate of soda and potash, a photograph, (see plate III) of three of the plants was taken May 6, nearly five weeks after the application of the fertilizer, in which a plant (42) having no fertilizer, another (47) having a maximum amount of raw bone meal and the third (84) having a maximum amount of all three ingredients, are represented. The vigorous growth of 47 is in direct contrast to the almost lifeless appearance of 84. Almost without exception, wherever nitrate of soda or muriate of potash had been applied in large amounts, more or less injury resulted to the plants. This was what might naturally be expected from the nitrate of soda, but in the case of the muriate of potash, it was not supposed that any reasonable amount would be injurious. Less injury from the fertilizers was noted the first season than in that of the second. This was probably due to the fact that the fertilizers were more evenly distributed throughout the soil during the former year. Though as a rule the nitrate of soda caused the most injury to the plants, immediately after its application, the injurious effects did not seem to be so permanent as that of the muriate of potash, as will be seen when the product of the plants are compared with each other.

Although it was not intended to continue the experiment the third season, yet it was found at the close of the second year's work, that some features of the experiment might be profitably investigated further, notably that of the effect of large amounts of nitrate of soda and muriate of potash, a comparison being also made as to the relative effect of muriate and sulphate of potash.

A

B

A.—Comparison of different forms of phosphate on roses:

1. without fertilizer (control plant).
6. medium amount of dissolved bone black.
25. medium amount of rock phosphate.
45. medium amount of raw bonemeal.
89. medium amount of superphosphate.

B.—Comparison of different amounts of raw bonemeal:

42. without fertilizer (control plant).
43. minimum amount of raw bonemeal.
45. medium amount of raw bonemeal.
48. maximum amount of raw bonemeal.

A

B

A.—Comparison of nitrogen and potash with raw bonemeal on roses:

42, without fertilizer (control plant).
45, medium amount of raw bonemeal.
73, medium amounts of raw bonemeal and nitrate of soda.
77, medium amounts of raw bonemeal and muriate of potash.
81, medium amounts of raw bonemeal, nitrate of soda and muriate of potash.

B.—Comparison of clay and black loam soils:

Clay:
136, without fertilizer (control plant).
109, medium amounts of dissolved bone black and muriate of potash.

Black loam:
61, without fertilizer (control plant).
128, medium amounts of dissolved bone black and muriate of potash.

Injurious effects from excess of nitrogen and potash on roses:

42, without fertilizer (control plant)

47, maximum amount of raw bonemeal.

84, maximum amounts of raw bonemeal, nitrate of soda and muriate of potash.

Poor. Medium. Good.

Example of the three grades of bloom.

The roses were wintered under the same conditions as in the preceding winter, and in the spring were again pruned closely, before sending out new shoots. The soil in the pots was found to have become so compacted during the two preceding years, as to preclude any possibility of its being retained longer. The plants were, therefore, repotted in soil of about the same character as that previously used. Previous to this operation, all of the old soil was removed from the roots of the plants, the soil adhering to the finer roots being washed off with water. Such of the fertilizers as were applied directly to the soil were incorporated with it previous to filling the can. Only the Kaiserin roses were used in the continuation of the work.

Some very decided changes were made in the grouping of the plants. Instead of having two plants in each combination, double that number were used. By using a larger number, the resulting effects of individual or accidental variation of the plants were greatly lessened. The kinds and amounts of fertilizers used are given in table IX. The same amount of available potash was used as in the preceding years, the only change being that a chemically pure article instead of the commercial one was used. The same change was also made with the nitrate of soda

In order to make a more extended comparison of the relative values of clay and black loam as a rose soil, a few plants were potted in black loam.

Product of the plant In considering the results obtained from the data on the number and quality of flowers produced by each plant, an attempt will be made to present tables in which different combinations of fertilizers are so arranged as to enable the reader to make a comparative study of their relative merits without much difficulty.

The roses were classified when cut as good, medium, or poor, (see plate IV) and upon this classification the value of the product from each plant was based. Values were assigned to each class or grade of roses as follows—good roses were valued as 1, medium at .7 and poor at .3. Such valuations were of course more or less arbitrary ones, but nevertheless it permitted of a closer and more uniform comparison of the total product. Taking them intheir natural sequence, the Kaiserin plants are the first to be discussed. A table (X) has been prepared in which

TABLE IX .

Kind and amount of fertilizers applied

NUMBER OF PLANT	Raw bonemeal, in grams	Muriate of potash (c. p.) in grams	Sulphate of potash (c p) in grams	Nitrate of soda (c. p.) in grams	Rate per square yard in ounces				REMARKS
					Raw bonemeal	Muriate of potash	Sulphate of potash	Nitrate of soda	
1,2,21,22	....	....	....	....	....	....	....	....	
3 4,5,6	8.219	....	....	....	7.71	....	....	....	
7,8,9,10	41.095	....	....	....	38.55	....	....	....	
11,12 13,14	41.095*	....	....	....	38.55	....	....	....	
15 16,17,18	8.219	....	....	3.068	....	....	....	2.88	
19,20,23,24	8.219	....	....	6.136	....	....	....	5.76	
25,26.27,28	8.219	....	....	6.136†	....	....	....	5.76	
29,30.31,32	8.219	....	4.113	....	....	....	3 86	....	
33 34 35.36	8.219	3.917	....	....	....	3.68	....	....	Clay soil
37 38.39 40	8.219	....	8.225	....	....	....	7.72	....	
43,44.45,46	8.219	7.834	....	....	....	7.36	....	....	
47.48,73 74	8 219	....	8.226*	....	....	....	7.72	....	
75.76,77 78	8.219	7 834*	....	....	....	7.36	....	....	
79.80,81.82	8.219	....	4.113	3.068	....	....	....	....	
83 84,86 87	8.219	3.917	....	3.068	....	....	....	....	
88,89.90.91	41.095	....	8.226	6.136†	....	....	....	....	*Two applications
92,144,145,146	41.095	7.834	....	6.136†	....	....	....	....	†Four applications
41,42.85	....	....	....	....	....	....	....	....	
147,148,149	8.219	....	....	....	....	....	....	....	
150,151,152	41.095	....	....	....	....	....	....	....	Black loam
153,154	8.219	....	....	6.136†	....	....	....	....	

the separate results of the three seasons for each group are presented, as well as that of the third season.

The average value of the control (unfertilized) plants is considered, as the normal product from the soil, and the per cent. of increase or decrease is figured on that basis, assuming such value to be 100.

TABLE X.

Average value of product from fertilized and unfertilized plants for 1896-1897-1898.

	Value of product for			Per cent. of increase or decrease over control for		
	1896	1897	1898	1896	1897	1898
No fertilizer	5.94	10.09	10.50	....	....	.....
I. Dissolved boneblack	5 74	10 82	......	− 3.37	+ 7.23	......
II. Rock phosphate	5.78	11.04	....	− 2.69	+ 9.42	......
III. Raw bonemeal	8.96	13.84	14.55	+50.84	+37.17	+38.91
IV. Superphosphate	7.07	12.17	......	+19.02	+20 61	.....

A marked increase is shown in groups III and IV, with the gain largely in favor of III, in which raw bone meal was used. Groups I and II show a slight decrease during the first season, with an increase in that of the second. It is not fair to infer, however, that the chemical fertilizers applied to I and II were in themselves harmful to the plants, but rather that the amounts and combinations were not best suited to their needs. If we compare those plants to which some form of phosphoric acid had been added, we again find that they were more or less divergent in their results, indicating that some forms were not adapted to the needs of the plant. The data which is presented in table XI, shows that III and IV gave an increase over the control, while with one exception I and II gave a decrease. As in the preceding table the gain is largely in favor of group III, amounting to over 51 per cent. the first season, 31 per cent. the second season and 27 per cent. the third. This is a good indication that raw bone meal will in itself produce a marked increase. It is altogether probable that some of this increase is due to the nitrogen content of the bone, which in raw bone meal, as has already been shown, amounts to over four per cent.

TABLE XI.

Average value of product from plants receiving phosphoric acid alone, with percentage of increase or decrease over control for 1896, '97, '98.

Phosphoric acid source	Value of product for			Per cent. of increase or decrease for		
	1896	1897	1898	1896	1897	1898
No fertilizer.......	5.94	10.09	10 50	....	....	....
Diss. boneblack	5.45	10.03	....	-- 8.25	— .59	....
II. Rock phosphate	6.55	9 82	....	+10.27	— 2.68	....
III. Raw bonemeal	9.	13.22	13.34	+51 52	+31.02	+27.05
IV. Superphosphate	8.25	10.38	....	+38.89	+ 2.87	....

In order to study the effects of nitrate of soda and muriate of potash when used in connection with phosphoric acid, separate tables have been prepared for each, in which the average results of the plants in eaeh group are compared with the control. The data obtained from plants receiving nitrate of soda and phosphoric acid will be found in table XII.

TABLE XII.

Average value of product from plants receiving phosphoric acid and nitrate of soda with percentage of increase or decrease over control for 1896, '97, '98.

Group	Value of product for			Per cent. increase or decrease for		
	1896	1897	1898	1896	1897	1898
No fertilizers......	5 94	10.09	10 50	....	....	....
Diss. boneblack & nitrate of soda..	7 58	13.23	....	+27.61	+31.12	....
Rock phosphate & nitrate of soda	5.50	13.40	....	— 7.41	+32.80	....
Raw bonemeal & nitrate of soda...	9.30	15.80	12.52	+56.57	+56.59	+19.24
Superphosphate & nitrate of soda..	7.85	15.68	....	+32.15	+55.40	....

It was found that, as a rule, a combination of phosphoric acid and nitrate of soda produced a better crop than did any other used. In only one instance did it result in a lessened product, and

that was probably due to some accidental variation rather than to any injury, for in this particular instance no injury from fertilizers was observed. The increase of groups III and IV was as in the preceding instances, quite a little in excess of the other two, with III showing a slight gain over IV. With the exception mentioned, groups I and II showed good gains over the control.

In table XIII is presented the data obtained from plants to which muriate of potash and phosphoric acid had been applied. In each instance, but one, the addition of muriate of potash resulted in a direct loss in the first season, group III showing a gain.

In the second season groups III and IV showed an increase, the former being considerably in excess of the latter. A comparison of group III for the three seasons shows the greatest gain in that of the last season.

TABLE XIII.

Average value of product from plants receiving phosphoric acid and potash with percentage of increase or decrease over control for 1896, '97, '98.

Group	Value of product for			P. cent. of increase or decrease for		
	1896	1897	1898	1896	1897	1898
No fertilizer........	5.94	10.09	10.50	....	....	....
Dissolved bone-black & potash..	5.50	9.25	....	— 7.47	— 8.33	....
Rock phosphate & potash.........	5.90	9.63	....	— .68	— 4.56	....
Raw bonemeal & potash..........	8.23	12 63	15.22	+38.35	2+5.17	+44.95
Superphosphate & potash..........	5.23	10.78	....	—11.95	+6.84	....

In order to include the different combinations, it is necessary to make one more comparison of the groups so that their several effects may be studied more closely. In this combination will be included plants receiving all three of the elements, phosphoric acid, potash and nitrogen. The average value of the product of these plants is presented in table XIV.

TABLE XIV.

Average value of product from plants receiving phosphoric acid, potash and nitrogen, with percentage of increase or decrease over control 1896, '97, 98.

Group	Value of product for			P. cent. of increase or decrease of		
	1896	1897	1898	1896	1897	1898
No fertilizer.......	5.94	10.09	10.05	....	....	....
Diss. boneblack, potash & nitrogen	5.05	11.25	....	+ 14.98	+ 11.25	....
Rock phosphate, potash & nitrogen	4.40	11.85	....	+ 25.93	+ 17.44	....
Raw bonemeal, potash & nitrogen	9.45	14.60	16.90	+ 59.09	+ 44.60	+ 60.65
Superphosphate, potash & nitrogen	6.60	12.73	....	+ 11.11	+ 26.16	....

As in some of the preceding tables, a considerable variation in the first season's product is obtained. For example, groups I and II are considerably inferior to the control plants, the former being about 16 per cent, and the latter about 26 per cent less. Groups III and IV on the other hand show a marked increase, the former of about 59 per cent and the latter 11 per cent. The second year's product, however, showed a marked increase throughout, averaging from 11.5 per cent to 44.6 per cent, the latter being from the plants in group III.

Without one exception, in the five preceding tables the product from the plants having raw bone meal, gave a marked increase in yield, averaging from 25 to nearly 60 per cent.

Having now considered the results from the group standpoint, it might be interesting as well as helpful to a better understanding of the effects of phosphoric acid, nitrate of soda and muriate of potash, to merge the four groups into one and thus enable the reader to note the general effects of these elements. Table XV contains the average increase from plants receiving phosphoric acid alone, and in combination with nitrate of soda and muriate of potash ,separately and conjointly.

TABLE XV. GROUPS I-IV.

Average value of products from plants receiving phosphoric acid alone, as well as in combination with nitrate of soda and potash, for 1896, '97, '98.

Fertilizers used	Value of product for			P. cent. of increase or decrease for		
	1896	1897	1897	1896	1897	1898
No fertilizer......	5.94	10.09	10.50	....	....	....
Phosphoric acid...	7.31	10.76	13.34	+23 06	+ 6.64	+27.05
Phosphoric acid & nitrate of soda...	7.55	14.57	12.52	+27.10	+44.40	+19.24
Phosphoric acid & muriate of potash.	6.22	10.57	15.06	+ 4.88	+ 4.86	+43.43
Phosphoric acid & sulphate of potash	......	....	15.38	....	....	+46.48
Phosphoric acid, sulphate of potash & nitrate of soda.	......	....	18.19	....	....	+73.24
Phosphoric acid, muriate of potash & nitrate of soda.	6.25	12.39	15.60	+ 5.22	+22.79	+48.57

With the exception of the third season's results, which in a measure, are not quite comparable with the preceding work, the plants receiving phosphoric acid and nitrate of soda gave the largest yield, while those having phosphoric acid and potash gave the poorest returns. These conditons are, however, reversed for 1898. Here we find that the poorest results were obtained from the phosphoric acid and nitrate of soda series, and that a combination of all three of the fertilizers gave the greatest increase. It must, however, be borne in mind that in this table the product from the raw bone meal series is lessened by the others. Plants receiving sulphate of potash gave better returns than those with muriate of potash, this being especially noticable where all three ingredients were used.

The presentation of a complete table of the different groups showing the effects of the varying amounts of fertilizers, may introduce some interesting data for consideration. In this table (XVI) is given the effects of a minimum, medium and maximum amount of phosphoric acid, and in the case of the two latter in combination with nitrate of soda and muriate of potash. As might be expected, numerous apparent contradictions were obtained especially with the medium and maximum amounts of nitrate of

soda and muriate of potash. No doubt much of this is due to the individual variation of the plants themselves, for when these are combined, that is those with medium and maximum amounts, as in the preceding tables, many of these variations are eliminated. In general, the plants receiving maximum amount of phosphoric acid gave an incresed yield over those receiving lesser amounts,

TABLE XVI.

Average value of product receiving varying amounts of phosphoric acid, nitrate of soda and potash.

Fertilizers used			Value of product for		P. cent. of increase or dec. based on control	
Dissolved boneblack	Nitrate soda	Muriate potash	1896	1897	1896	1897
....	....	....	5.95	10.09	....	....
min.	....	....	4.10	9.20	—30.98	— 8.82
med.	....	....	5.95	9.60	+ .17	— 4 86
max.	....	....	6.30	11.30	+ 6.06	+11.99
med.	med.	....	8.10	15.40	+36.36	+52.63
med.	max.	....	7.05	11.05	+18.69	+ 9 51
med.	....	med.	5.	10.55	+15.82	+ 4.86
med.	....	max.	6.	7.95	+ 1.01	—21.21
med.	med.	med.	4.05	12.80	—31.82	+26.86
max.	max.	max.	5.05	9.70	—14.98	— 3.87
Rock phosphate						
min.	....	....	5.65	9.10	— 4.88	— 9.81
med	....	....	6.20	10.85	+ 4.38	+ 7.53
max.	....	....	7.80	9.65	+31.31	— 4.36
med.	med.	....	4.25	13 55	—28.45	+34 29
med.	max.	....	6.75	13.25	+13.64	+31.32
med.	....	med.	6.45	10.30	+ 8.59	+ 2.08
med.	....	max.	5.35	8.95	— 9.93	—11.30
med.	med.	med.	5.20	12.45	—12.46	+23.39
max.	max.	max.	4.40	11.25	—25.93	+11.50
Raw bonemeal						
min.	....	....	6.90	12.35	+16.16	+22.40
med.	....	....	8.45	13.95	+42.26	+38.26
max.	....	....	11.65	13.35	+96.13	+32.32
med.	med.	....	12.10	14.70	+103.70	+45.69
med.	max.	....	6.50	16.90	+ 9.43	+67.49
med.	....	med.	9.30	13.10	+ 56.57	+29.83
med.	....	max.	7.15	12.15	—20.37	+20.42
med.	med.	med.	9.15	16.15	+54.04	+60.06
max.	max.	max.	9.45	13.05	+59.09	+29.33
Superphosphate						
min.	....	....	8.65	10.40	+45.62	+ 3.07
med.	....	....	7.30	10.30	+22.89	+ 2 08
max.	....	....	8.80	10.45	+48 15	+ 3.57
med.	med.	....	8.55	15.20	+43.94	+50 64
med.	max.	....	7.15	16.15	+20.37	+60.06
med.	....	med.	5.20	11.10	—12.46	+10.01
med.	....	max	5.25	10.45	—11.62	+ 3.57
med.	med.	med.	6.10	12.50	+ 2.69	+23.88
max.	max.	max.	6.60	12.95	+11.11	+28.34

the same being true of the medium over the minimum. Quite different conditions are found when we compare the nitrate of soda series; here we find that the increase is about as frequent in the case of the lesser as of the greater amounts. In only one instance did the product fall below that of the control plants. Judging the muriate of potash from the same standpoint, practically the same results are obtained, but with the choice in favor of the lesser amount. It should be noted, however, that quite frequently the product falls below that of the control, showing that in these instances the fertilizers applied were not beneficial to the plants.

In the preceding table (XVI) no reference has been made to the third season's work, this omission being purposely made in order to present in the succeeding table the results obtained from the use of raw bone meal for the whole period. The data being so arranged as to permit of easy comparison wherever duplicate conditions existed. Perhaps the most valuable feature in this table is that of the decreased product from the application of a large amount of nitrate of soda, when all applied at once. Compared with the product from plants receiving the same amount in four applications, we find that while in the former there is only a gain of a little over three per cent, the latter shows a gain of about 36.5 per cent. Another notable increase is found in the case of the two sets of plants receiving maximum amounts of sulphate of potash, those receiving this amount in two applications show a gain of nearly 80 per cent, as against a gain of a little over 8 per cent, for those with one application. In direct contrast to these figures we find that the muriate of potash series only show a slight gain amounting to about 1 per cent in favor of two applications. While in the case of raw bone meal alone we find a large decrease, thereby showing at least that a sufficiently large amount of phosphoric acid in the form of bone meal may be applied at once to the plants without fear of injury.

The increased yield from plants receiving sulphate of potash as against muriate of potash, is an indication that potash having its source in the former material is better adapted to rose culture. From the limited data at hand, however, the writer does not feel justified in drawing any very decided conclusions therefrom, as different soils might change the results.

In considering the effects of all three fertilzers when used in combination, it is evident from a comparison of the preceding seasons with that of the latter, that there was a decided gain in

the successive applications of nitrate of soda as against a full application at the time of setting the plants. This result was not an unexpected one for the injurious effect of large amounts of nitrate of soda is well known.

TABLE XVII. Raw bonemeal series.

Average value of product from the different combinations of fertilizers with the percentage of increase or decrease over control for 1896, '97, '98.

Ra						...t for 1898			...ase or ... 1898.
N						10.50	....	....	....
M						... ..	+16.16	+22.40	....
M						13 95	+42 26	+38.26	+27.14
M						15.63	+96.13	+32.32	+48.86
M						11.05	....	....	+ 5.24
M						12.40	+103.70	+45.69	+18.09
M						10.83	+9.43	+67.49	+ 3.14
M						14.33	....	....	+36.48
M						13.93	+56.57	+29.83	+32.67
M...						15.58	+20.37	+20 42	+48.38
Med. am't	None	Max. am't†	None	....	....	15.68	....	....	+49.33
Med. am't	None	None	Med. am't	....	....	15 88	....	....	+51 24
Med. am't	None	None	Max. am't	....	....	11.38	....	....	+ 8.38
Med. am't	None	None	Max. am't	....	....	18.88	....	....	+79.81
Med. am't	Med. am't	Med. am't	None	9.15	16.15	13.90	+54.04	+60.06	+32.38
Med. am't	Max am't	Max. am't	None	9.45	13.05	.....	+59.09	+29.33	....
Max. am't	Max am't*	Max. am't	None	....	....	17.30	....	....	+64.76
Med. am't	Med. am't	None	Med. am't	....	....	16.48	....	....	+56.96
Max. am't	Max. am't*	None	Max. am't	....	....	19.90	....	....	+89.52

*Four applications, the last three being made in liquid form by sub-watering.
†Two applications, the last one being made in liquid form by sub-watering.

Thus far we have only considered the results obtained from the Kaiserin roses. The reason for so doing lies in the fact that they proved best adapted to the conditions under which they were grown. Although group V of the Perle roses was an exact dulpli-

cate of group I in so far as the chemical fertilizers were concerned it should be borne in mind that the pots in which they were grown were considerably larger. This together with a different variety does not admit of any very close comparison of results For the sake of the readier examination, however, a table has been prepared, in which is given the data, obtained from these two groups for both seasons, showing in detail the results obtained from the different chemical combinations. The average

TABLE XVIII

Comparison of the value of the product from groups I and V, in which dissolved boneblack was used for 1896 and 1897.

			GROUP I. Kaiserin roses.		GROUP V. Perle des Jardins.		GROUP I Kaiserin roses.		GROUP V. Perle des Jardins	
Dissolved boneblack	Nitrate of soda.	Muriate of potash.	Value of product for 1896	Value of product for 1897	Value of product for 1896	Value of product for 1897	Per cent. Increase or Decrease 1896.	Per cent. Increase or Decrease 1897	Per cent. Increase or Decrease 1896.	Per cent. Increase or Decrease 1897
Min.	....	....	5.94	10.09	5.50	11.15	....	....	....	....
Min.	....	....	4.10	9.20	5.95	12.15	-30.98	- 8.82	+ 8.18	+ 9.87
Med.	....	....	5.95	9.60	7.75	13.50	+ .17	- 4.86	+40.91	+21.08
Max.	....	....	6.30	11.30	7.30	13.40	+ 6.06	+11.99	+32.73	+20.79
Med.	Med.	....	8.10	15.40	9.90	13.05	+36.36	+52.63	+80.	+17.04
Med.	Max.	....	7.05	11.05	6.05	11.85	+18.69	+ 9.51	+10.	+ 6.28
Med.	....	Med.	5.	10.55	9.80	13.25	-15.82	+ 4.56	+78.18	+18.83
Med.	....	Max.	6.	7.95	6.65	11.05	+ 1.01	-21.21	+20.91	- .90
Med.	Med.	Med.	4.05	12.80	8.40	11.55	-31.82	+26.86	+56.36	+ 3.59
Max.	Max.	Max.	5.05	9.70	5.60	14.20	-14.98	- 3.87	+ 1.82	+27.35

product from the unfertilized plants for 1896 shows a slight advantage in favor of group I and vice versa for the ensuing year. The Perle des Jardins plants receiving phosphoric acid alone gave much larger yield than did the Kaiserin plants. Those having phosphoric acid and nitrogen did not vary to any appreciable extent if the product of both seasons is considered. Plants having phosphoric acid and potash for their food supply gave much better results in group V for both seasons than in group I. This was also true for those to which all three ingredients had been applied. From the data presented the Perle roses gave the best results, from the application of fertilizers. The growth of the plants was, however very much inferior, and as a rule the roses were of an inferior quality.

Through an error in the application of the liquid manure to group VI, the data obtained was discarded.

Only four plants were used in group VII, these being compared with the control plants used in group V. Two of these plants received a medium amount of the acidulated ground bone and potash and the remaining two a maximum amount. Contrary to expectations these plants gave a large increase over those of the control, the increase during the first season being greater than that of the second. In both instances the per cent. of increase was greater from the plants receiving the lesser amount of bone-acid bonemeal as precisely the same thing occurred with some
acid bonemeal as precisely the same thing occurred with some
of the other forms of phosphoric acid. In table XIX will be found the average value of the product from these four plants, including that of the control.

TABLE XIX.

Average value of product from Group VII.

Acidulated ground bone	Av. value of product for 1896.	Av. value of product for 1897.	Av. per cent of increase or decrease 1896.	Av. per cent of increase or decrease 1897.
....	5.50	11.15	....	....
Med. am't	10.05	16.35	+82.73	+46.64
Max. am't	6.90	15.40	+25.45	+38.12

As has been previously stated it is generally conceded that a clayey soil is best adapted to the growth of roses, hence a comparison of plants grown in such a soil with those grown in one wholly different, should possess some interesting features. As previously mentioned in this report, group VIII contained

plants of the Perle des Jardins rose, part of which were grown in clay soil and part of them in a black loam, in which plants grown in the latter soil were superior to those of the former. In order to secure more data on this point some of the Kaiserin roses were also grown in the black loam during the season of 1898. While the results of the two experiments do not coincide exactly, it has

TABLE XX.

Comparison of product from clay and black loam soils for 1896, '97, '98.

Kind of soil.	Kind of fertilizer used in grams.			Average value of product.			Per cent of increase or decrease.		
	Dissolved boneblack.	Raw Bonemeal.	Muriate of Potash.	1896	1897.	1898			
Clay loam	None	None	None	5.50	11.15	10.50	......	......	......
Black loam	None	None	None	8.80	12.85	9.70	+60.00	+15.25	7.62
Clay loam	2.728	None	4.194	9.80	13.25	......	+78.18	+18.83	......
Clay loam	None	8.219	None	......	......	13.35	......	......	+27.14
Clay loam	None	41.095	None	......	......	15.63	......	......	+48.86
Black loam	None	8.219	None	......	......	3.43	......	......	-67.33
Black loam	None	41.095	None	......	......	5.60	......	......	-46.67
Black loam	2.728	None	4.194	14.60	......	......	+165.45	......	......
Black loam	None	41.095	None	......	19.70	......	......	+76.68	......
Black loam	None	61.643	None	......	24.45	......	......	+119.28	......
Potting soil	None	None	None	......	......	12.31	+123.64	......	......

been thought best to present the data and thus give the reader an opportunity to judge for himself in regard to the relative merits

As has been said, the results of the experiments with black and clay loams in growing Perle des Jardins and Kaiserin roses, do

not agree. For example the unfertilized or control plants show an increase of 60 per cent in favor of the black loam the first season, and a little over 15 per cent the second. Comparing these figures with those obtained the third season, we find that instead of having an increase in favor of the black loam plants there is a decrease of 7.62 per cent or an increase for those in clay loam of over 8 per cent. This seeming discrepancy cannot be attributed to the soil or watering, for all received uniform treatment. The only tenable theory by which the contradictory results may be answered, is in the assumption that the black loam is better adapted to the Perle than to the Kaiserin rose, an assumption which is corroborated by actual observation on the growth of these plants, side by side in the same ground outside. Practically the same results were obtained in the use of the chemical fertilizers. The increased yield being noticeably greater with the Perles in the black than in the clay loam and vice versa with the Kaiserin roses. A promising feature of the experiment is the comparatively large increase in rose production from the plants receiving an unusually large amount of raw bone meal. The increase in this case over those receiving a maximum amount was over 24 per cent. The value of this part of the experiment lies not so much in the actual value of the gain, as it does in that it illustrates the fact that large amounts of phosphoric acid in the form of raw bone meal, amounts far in excess of the actual requirements of the plants, may be applied to the soil previous to setting the plants, and this too without in any way endangering the vitality of the plants. The amount applied in the case just mentioned, 61.643 grams, per pot, is equal to about 2 1-3 pounds per sq. yd.

The maximum amounts of raw bone meal, nitrate of soda and the muriate and sulphate of potash applied to the Kaiserin roses, estimated to the square yard, were approximately as follows:

Raw bone meal..........	41.095 grams ..	2 lbs. 6 oz. per sq. yd.
Nitrate of soda (com.)....	6.290 grams ..	6 oz. per sq. yd.
Muriate of potash (com.)..	8.387 grams ..	8 oz. per sq. yd.
Sulphate of potash (c. p.)..	8.226 grams ..	8 oz. per sq. yd.
Sulphate of potash (com.).	9.492 grams ..	9 oz. per sq. yd.

The raw bone meal used in the experiment was obtained of the Empire Carbon Works, St. Louis, Mo., and is listed by them at $25.00 per ton. The other ingredients used were obtained from various sources.

SUMMARY.

There is every reason to believe from the results obtained in the several experiments enumerated, that chemical fertilizers when properly used may be made to serve every need of the rose plant so far as food is concerned.

The use of raw bone meal in every instance gave an increased yield over that of the control plants, as well as giving a greater percentage of gain than did those receiving other forms of phosphoric acid.

Pure bone meal is not injurious to rose plants, even when applied in amounts largely in excess of the requirements of the plant.

The acidulated bone meal which has been used by florists and supposed to be harmful, did not produce any noticeable injury, even when used in large amounts.

As a rule, a combination of phosphoric acid and nitrate of soda gave better results than one of phosphoric acid and muriate of potash.

Two or three applications of potash during the season was found to be preferable to a single application, although in some instances no injury from the single application was apparent.

A larger number of Perle roses were produced from plants grown in a black than in a clay loam, while the Kaiserin gave reverse results.

The sub-watering method proved an efficient means of supplying the plants with moisture.

Insects. The only insects that were at all troublesome to the roses were thrips. These mites infested the young buds, being found safely ensconced between the unfolded petals of the flower. Their presence could always be detected in the opening of the bud, by the brownish discoloration of the injured petals. When the thrips were present in large numbers this injury was sufficient to cause the petals to adhere to each other and thus prevent the bud from expanding. During the first season they affected the plants but little, while in the succeeding two seasons they were present in large numbers on two or three separate occasions. Generally these visitations occurred during a long period of hot, dry weather. It must be remembered that the plants were in the open air most of the time, and at all times were subject to the prevailing atmospheric conditions.

Insecticides. Frequent spraying of the plants with a weak solution of Rose Leaf Extract of Tobacco, one part of the extract to 75 parts of water, proved efficacious. The spraying was done in the evening, and followed up in the morning by a hard syringing with water. Three or four applications were generally sufficient to destroy or drive away the thrips.

THE MAMMARY GLAND.

By A. W. Bitting, D. V. M.

The mammary glands are accessory organs of generation for the purpose of supplying nutrition to the young from birth until they attain sufficient development to subsist on food independent of the mother. They are the characteristic organs of all mammals (animals that suckle their young). They differ in number, size, position and minor characters in the different species, but their function is the same—the secretion of milk. In a wild state the glands secrete only what is needed for the offspring and continue their function for a variable time, until the young can subsist alone. The secretion from this gland is very nutritious and easily digestible. For this reason constant efforts have been made in domesticating animals to secure an increase in the quantity of milk, that it might be used as a food for people. How successful these efforts have been is attested by the numerous breeds of cattle noted for the quantity and quality of the milk which they produce. The efforts at improvement have been attended by wonderful success in increased production and in lengthening the period of lactation, but there has not been a corresponding improvement in quality.

The mammary glands are true skin glands, and are to be regarded as comparable in their development to the sebaceous (oil) and sweat glands. By some they are regarded as modifications of the oil glands. The claim of relationship is based upon the fact that the secretions are much alike in that they are both rich in fatty and albuminous material. Others regard the mammary glands as modifications of the sweat glands. This resemblance is based upon their structural characters. The alveoli of the mammary glands have only a single layer of epithelial cells, a characteristic of the sweat glands. Haidenhain has shown[4] that there is no fatty metamorphosis of the central cells in the milk glands, as in the case of the sebaceous glands, which shows that they do not agree in their physiological method of forming the fats. The weight of argument therefore seems to show that the gland is more closely related to the sweat glands than to the sebaceous glands.

The evolution of the mammary gland as shown by a study of the different forms of mammalia, is of considerable interest, but only types can be cited here. In a very low form, Ornythorynchus,

[4]Herman's Physiologie, Bd. V., pp. 380.

THE MAMMARY GLAND.

An antero-postero section of an udder showing injection of the fore and hind quarters with different colored mass. This brings out the distinct line of separation and also the difference in shape of the quarters. This udder shows a large amount of glandular tissue and small but numerous milk cisterns

THE MAMMARY GLAND.

An injected udder showing large milk cisterns but small amount of glandular tissue.

M1oU

THE MAMMARY GLAND.

Plate viewing the udder from above, showing the veins completely encircling the udder and leading away both forward and backward.

THE MAMMARY GLAND.

A view showing the exposed milk veins of belly.

THE MAMMARY GLAND:

A schematic figure showing the course of the artery leading to the mammary gland and the veins returning to the heart. The light colored lines represent arteries and the dark colored lines the veins.

the glands consist of a series of about 200 club like tubes, opening close together at two points on the surface of the skin. These masses lie on each side of the body and there is no depression or pouch, or elevation of teat to indicate the location of the openings, and they can only be distinguished by the fact that the opening of the ducts is larger than for the hair. The milk exudes and is licked off of the hair by the young.

In the Echidna the glands resemble those in the preceding class, but instead of each emptying separately upon the surface of the skin, they all empty into a small pouch or pocket formed by a fold of skin. The mouth parts of the young are adapted to the pouch.

In the marsupials, the glands are more compacted, and small follicles are formed, into which a number of these ducts enter. There are from 10 to 20 of these follicles, and each empties through a separate duct upon an eminence on the outside. This eminence corresponds to the teat, and is very rudimentary in some forms, and in a few it is quite well developed. The mammary glands of all the higher animals is only a more perfect development of the types already cited. In the dog the gland is thin and flattened, and the lobules have their ducts, which empty into still larger ducts, and these into still larger ducts, which become dilated to form pouches that act as reservoirs for retaining the milk for some time. These larger ducts, about 16 in number, are separate from each other, and discharge on the end and sides of the teat through as many openings.

In the sow the development is carried still further. The larger ducts empty into a few large cavities or reservoirs and discharge on the end of the teat through two openings. In the mare the form of the gland is more compacted, the lobules are brought close together, there is a diminution of the adipose and connective tissue, the reservoirs are better defined, the teat more perfectly developed and two glands discharge on the end of the same teat. In the cow there is a development of a larger amount of gland tissue, the presence of large and small milk ducts and reservoirs or cistern capable of great distention. The discharge is from a single duct at the end of a well developed teat.

The number and position of the mammary glands is quite variable in the different species. A single pair is the smallest number found, and 11 pairs the largest. In general it may be said, that animals that bring forth only one at a birth usually have only a single pair of glands, while multiparous animals

usually have more glands than the average number of young to which they gave birth. While the foregoing may possibly be taken as a general rule, there are many exceptions. Probably the most notable exception is the cow, for while she ordinarily produces only one at a birth, she has four well developed glands, and often has from one to four rudimentaries. The query naturally arises, Was the cow at one time multiparous, and are the glands persistent? Also, if such be the case, were the glands distributed along the abdomen, and have they become crowded together in the inguinal region?

The udder of the cow consists of a variable number of mammary glands, usually four, that are functional (the quarters) and from one to four are rudimentary. They are arranged in pairs, being on opposite sides of the median line of the body, and occupy the inguinal region (groin). The fore part of the udder begins a few inches behind the umbilicus, and the glands continue backwards, going well up between the legs. The right and left sides of the udder are separated by a well defined line or groove. Viewed from the side, the udder presents a more or less rounded sacculate appearance. The forequarters terminate more abruptly than the hind quarters. The line of separation between the fore and hind quarters is not well marked upon the side, may not be well marked below, and is never so pronounced as the separation between the two sides.

The shape and size of the organ as a whole, differs in the different breeds and in individuals of the same breed. In some breeds the aim has been to develop a large secretory function, and an enormous glandular development has been the result. In other breeds, the quality of the milk has been the prime consideration, and the gland is smaller. In the beef breeds the gland is often invaded with fatty tissue, and the udder appears large, but the quantity of glandular tissue is small. The shape also depends upon the eveness of development of the individual gland, upon the strength of the supporting ligaments and the presence of rudimentary glands. An udder with quarters not in pairs or quarters not uniform in size, presents a bad shape to the eye of the critic. An udder with little or no fat or connective tissue in front to protect the large vessels as they emerge to pass along the abdominal walls, will terminate abruptly. An udder with thin flat rudimentaries or without any at all, will present a smoother outline behind, than one in which they are well developed.

The appearance of the organ as regards size will depend in a

measure upon the strength and shape of the abdominal wall. In a cow with loose abdominal walls, dropping directly down from the pubis, thus forcing the udder downward and backward, the organ will appear to be much larger than in one in which the walls are stronger. This sometimes accounts for the apparently sudden development of a good udder after the second or third calf. The muscles of the abdomen become more relaxed and the udder becomes more pendulous. As the gland is located just under the skin, the shape and size may be fairly judged, but accurate measurements cannot be made. The weight of the dissected udders as found in our investigations, varied from two pounds and three ounces to 41 pounds and six ounces.

The skin covering the udder is very thin and elastic, and the hair is finer, softer and shorter than on other parts of the body. The skin covering the teats is deprived of hair or nearly so, and is often of a darker color than upon other parts, thus resembling the areola. The soft skin of the udder is carried well up backward and blends with the escutcheon or milk mirror. The so-called milk mirror bears no relation to the size of the gland as it may extend several inches above or to each side.

A dissection of the udder shows that each half is enveloped in a strong fibrous capsule, and that the fibers intermingle on the inner side and are prolonged upwards to act as ligamentous support for the gland. The halves are distinct, as they may be easily separated throughout their inner aspect. The individual glands in each half of the udder are not so distinctly separated. No line of division can be found upon the side, and very little evidence of such separation below. If a longitudinal incision be made through each half, in an uninjected state, no line of separation will be found to exist. For this reason many anatomists and writers have held that there are only two mammary glands and that each is provided with two or more openings. This probably also accounts for the popular belief that if an injury should occur, to one quarter, that at least part of the milk of that quarter may be drawn from its associate on the same side. If, however, an injection be made into each teat, using as many colored injection masses as teats injected, it will be found that a distinct transverse partition is present and that the injection mass in no case can leave the quarter. It therefore follows that milk drawn from any teat must be produced in that quarter. This udder formation is illustrated in plate V.

The quarters upon each side, when taken together, present a

somewhat convex border above and concave below, terminating somewhat abruptly in front and being prolonged upward and backward to a point. The forequarters are flattened above and below, and the hind quarters present more of a spherical triangle with the apex above and backward. The sides of the halves are about parallel in the udder when fairly distended with milk. The rudimentary glands are usually thin and flat and placed behind the so-called hind quarters. They may vary in number from one to five, and may occupy any position from in front of the forequarters, between the quarters, on the teat, to well up behind the hind quarters. This occurrence in front of the forequarters must be exceedingly rare, as I have never met but two slaughter-house inspectors who had observed that condition. The occurrence between the quarters is occasionally seen. The rudimentary glands usually have their own teat directly below them, but in some instances the teat may spring from the side of the large teat or an opening may occur upon the side of the teat. In the cases of openings on the back or sides of the hind teats, I have found that more of them are openings from rudimentary glands than into the cavity of the teat as usually supposed.

The structure of the mammary glands can be studied to advantage by injecting each teat, and the arteries and veins with different colored injection masses. Each gland is enveloped in an elastic, fibrous capsule or membrane to which externally the skin is loosely adherent; internally the fibers intermingle with those of the gland from the opposite side and become prolonged upward as a suspensory ligament. The intermingling is not strong, however, as they may be separated easily upon dissection. Between the glands on the same side the capsule sends off a transverse partition common to each. The tissues of the capsule become greatly thickened and are prolonged downward to form the walls of the teat. The capsule throws off numerous reflections inward from all sides to serve as a supporting framework for the gland tissue, and for the formation of the milk cisterns and ducts. This capsule and its reflections are very elastic, thus yielding readily to the change of form produced by the frequent filling and emptying of the gland.

The teat or external opening of the gland is cylindrical or conical in shape, of greater or less length and diameter, situated at the most dependent portion of the gland. Its shape and size are independent of the size of the gland. The teat is very elastic. It is covered with a tough, closely fitting, thin skin. Within it

contains the duct or milk canal. In a collapsed state, the walls of the canal lie in longitudinal folds, but when the teat is fully distended these folds are obliterated. In a moderate sized teat, the capacity of the canal when distended is from one to one and a half ounces. The teat is supplied with circular and longitudinal muscular fibers. At the lower end the circular fibers form a sphincter to close the duct and maintain it in that condition under ordinary pressure. At the upper end of the teat is another construction, but it does not completely close the canal, and still above is sometimes found a third. These upper constrictions correspond in position to the upper and lower layers of the capsule of the udder, and are the parts usually involved in imperforate quarters. The teat is provided with a copious vascular supply, but has no erectile tissue. Under undue excitement the arteries become greatly distended with blood, and produce a turgidity resembling erection, as in erectile tissue. This is observed in nymphomania and sometimes during the process of milking.

Above the teat is a large cavernous opening, the reservoir or milk cistern. This cistern is divided by constructions into pockets of various sizes into which the larger milk ducts empty. At the point of interest of these ducts is a constriction due to a sphincter muscle. These sphincters cannot close the entire opening, but it seems possible that they may partially do so, and this may thus account for the condition known to all dairymen as "holding up the milk." Reference to plate V will show the sphincter muscles and their location.

The large ducts ramify in an irregular manner to all parts of the gland. They subdivide into smaller ducts, and these in turn into smaller ones, until they terminate in a simple duct with its alveolus or pocket. The large ducts anastomose very freely, but do not in the smaller subdivisions. The canal in the teat, the reservoir and ducts are lined with columnar epithelium, but just what part the epithelial cells lining these ducts have in the production of milk is not known.

The alveolus is the sacculated distention on the end of the minute milk duct. It is the essential part of the gland. It is lined by a single layer of epithelial cells, which are especially concerned in milk secretion. The cavity of the alveolus in the cow is from one two hundred and fiftieth to one one hundredth of an inch in length, and from thirteen hundreths to one eight-hundreths of an inch in diameter. The lining cells vary from almost a flattened

form to a columnar form during the different stages of rest and activity.

The mammary glands are abundantly supplied with blood. The arterial supply leaves the heart through the posterior aorta and passes backward. This artery divides into two large branches known as the common iliacs. The common iliacs are short and divide into the external and internal iliacs. The blood for the mammary gland passes through the former as far down as the pubis, at which point a branch is given off, known as the prepubic (deep epigastric of man). The prepubic artery divides into two branches, the posterior abdominal and the external pudic and the latter into two parts, one going to the subcutaneous abdominal muscles and the other to the mammary gland in the female. For the blood to reach the udder it must pass through the posterior artery to the common iliac, the external iliac, the prepubic, external pudic, and the mammary. The mammary artery has four principal branches, two going to the posterior gland, one branch between the glands, with nearly all its subdivisions entering the anterior gland. There is also a small branch for each rudimentary gland. The large branches subdivide within the gland tissue.

The veinous circulation is more complex than the arterial. The blood is collected from the gland by from 14 to 17 large vessels, which empty into the mammary vein, which runs parallel with the artery at the base of the gland. The mammary vein on each side is divided into two parts, and these anastomose in front and behind the glands. A third large branch collects the blood from the teats, and the more dependent parts of the glands, extends forward and unite with the external branch above. The mammary vein enters the external pudic vein posteriorally, and the blood is conducted through the prepubic, the external iliac, the common lilac, and the vena cava to the heart. The mammary vein also passes forward and becomes a part of the subcutaneous abdominal, and this becomes the internal thoracic, and returns to the heart by the way of the anterior vena cava. The mammary veins from the glands on opposite sides anastomose both in front and behind, as shown in plate VII, so that there exists a complete circuit of veins around the whole group of glands, and a complete circuit of veins leading to the heart both forward and upward. The only thing that determines the direction of the blood is the position of the valves in the vessels. The larger volume of blood passes forward through the subcutaneous veins, thus bringing them into great prominence, and giving rise to the

popular name of milk veins. These abdominal veins enter the thoracic cavity just behind the sternum on each side of the cartilage, the point of entrance into the body being known as the "milk well." See plate VIII. As the blood may pass to the heart through the posterior vessels as well as the anterior, it would seem that undue prominence is attached to these veins in judging the milking qualities of cows. If a large volume of blood should return by way of the posterior vessels, the abdominal veins will appear less prominent. One of the factors tending to increase the size of these veins is pressure upon the iliacs as a gravid uterus.

The course of the circulation in the udder will be better understood by reference to plate VIII, as well as plate IX, showing the course of circulation between heart and udder.

The lymphatic circulation is also well developed. A very large lymphatic gland occupies the space above and behind the glands.

The nerve supply arises from a branch given off at the last dorsal vertebrae. The nerve center controlling secretion has not been located, but it is supposed to be in the spinal cord. It is possible that the will can exercise some influence, but the evidence is not sufficiently clear to warrant drawing a positive conclusion.

PSEUDO SCABIES.

By A. W. Bitting, D. V. M.

Early in February of the present year reports were received from Wabash county, that sheep had been brought into that locality affected with scabies, and furthermore, that the skin was affected with black worms. A number of sheep died and neighbors feared the presence of a new disease and the spread of infection. The correspondents were referred to the Live Stock Sanitary Commission, as being the proper authorities to deal with the question. On February 14, the Commission visited the place and placed a quarantine upon the flock. Later, the owner, not being satisfied with the condition of things, sent part of the carcasses of sheep that died to the Station for examination. No scabies were found and the "black worms" in the pelt proved to be the awns of *Stipa spartea*, a grass which grows in the southwestern States, from which place these sheep had been imported. The awn or beard of this grass is very long and has great powers of penetration. The awn when started in the ground forces itself downward by the straightening due to the absorption of moisture. The beards had gotten into the skin of the sheep while grazing, and had worked along in the loose tissue beneath. The pieces ranged from one

fourth to two and one half inches in length, and in some cases the whole seed pod had been carried with them. In only a few cases had abscesses occurred. In many places the local irritation was such as to cause the dropping of the wool in patches, thus giving a very ragged appearance to the fleece.

The cause of death, however, was due to lung and intestinal parasites.

THE EFFECTS OF EATING MOULDY CORN.

By A. W. Bitting, D. V. M.

During the fall and winter of the past year the State suffered the loss of a large number of cattle, supposedly due to the eating of mouldy corn. The fall of 1898 was exceptionally wet, and large quantities of corn spoiled and were fed in that condition. The popular belief is that the mould or other organism producing the fermentation in the corn also causes disease in the stock. The direct experiments to prove this point have usually given negative results.

In cooperation with the Botanical Department of the Station an attempt was made to separate these organisms and to determine the specific effect of each. Samples of mouldy corn were obtained from various sources, and it was found that three organisms, one bacterium and two moulds, were constant in the spoiled corn, and that the other bacteria and moulds were not constant.

Two horses were obtained, and after a preliminary feeding period, 5 c.c of an active growth of bacteria in boullion solution were inoculated subcutaneously and 36 hours later 10 c.c. more were injected. The effect upon the animal was not appreciable; not even so much as an abscess occurred. After a period of five days a similar test was made with one of the moulds, and after a like interval the other mould was tried. Neither of the moulds caused any trouble.

The next step was to sterilize large quantities of corn meal, make a mash and inoculate with pure cultures of these same germs. By giving as a mash, by mixing with dry meal and by starvation on other foods, it was possible to get each animal to eat about five pounds per day for five days during each of the three periods. The effect of the meal inocculated with the bacteria and one of the moulds was negative. The effect of the culture containing one of the moulds—a fusarium—produced redness of the gums and some salivation. The next attempt was to feed all the spoiled corn the horses would eat. They ate the corn

very well for three days, and after that it was with difficulty that they could be induced to eat any. On the fifth day, one of the horses had slight salivation, occasional colicy pains, and diarrhea. On the seventh day there was some incoordination of movement and stupor. For two days the animal would stand part of the time with the head pressed against the wall, and then quick recovery followed. The second horse showed some irritation of the mucuous membranes of the mouth, but never developed any nervous symptoms. The horse was killed, but a post mortem examination failed to show any lesions. The two horses ate together about four bushels of spoiled corn, most of it being consumed during the first week. After the first week the corn had to be mixed with other feed in every conceivable manner in order to induce the horses to eat any of it.

The results of the experiment show that inoculations with cultures of the bacteria and moulds were ineffective, that the eating of the mashes containing pure cultures showed that only in the case of a growth of a species of fusarium did any intestinal disturbance follow, and that in one case the feeding of the rotted grain produced considerable intestinal disturbance and some nervous symptoms, but that the disturbance was light in the other. The disease from which the animals were reported to have died in the State was cerebro-spinal-meningitis, but the experiment did not result in the production of such disease.

CONTINUED EFFECTS OF FERTILIZING THE SOIL

By W. C. Latta.

The piece of ground devoted to this experiment has grown corn continuously since 1880. The purpose of the experiment is to determine the lasting effect of horse manure, gas lime and ammoniated phosphate in continuous corn culture. There are 18 plats in the series, each one rod wide and 10 rods long. The even numbered plats have not been fertilized since the experiment began in 1880.

The odd numbered plats received applications of gas lime, ammoniated phosphate and fresh horse manure in 1883 and again in 1884. The plats receiving each kind of fertilizer and the aggregate amounts applied in the two years are:

	Applied per acre.
Gas lime (Plats 1, 7, 13)...........................	500 pounds.
Ammoniated phosphate [5] (Plats 3, 9, 15)..........	500 pounds.
Horse manure (Plats 5, 11, 17)....................	50 tons [6].

These plats have not been fertilized before or since the dates named above.

The effect of the gas lime and ammoniated phosphate, on the yield of grain, has been slight and transient, while that of the manure has been marked and lasting, as will appear from table XXI.

[5] The ammoniated phosphate contained 1.75 per cent. available and 4.09 per cent. insoluble phosphoric acid; 3.32 per cent. ammonia, and 1.07 per cent. potash K_2).

[6] Estimated.

TABLE XXI.

Average yields of corn in bushels per acre, with and without fertilization.

Year	Treatment of Plates	Gas lime	Ammoniated phosphate	Horse manure
1883	Av. 3 fertilized plats	44.05	53.36	56.95
	Av. 5 or 6 flanking plats	47.88	52.90	47.60
	Av. gain from fertilization	*—3.83	.46	9.35
1884	Av. 3 fertilized plats	38.23	40.68	53.48
	Av. 5 or 6 flanking plats	40.96	40.30	39.08
	Av. gain from fertilization	—2.73	.38	14.40
1885	Av. 3 fertilized plats	45.03	44.26	63.69
	Av. 5 or 6 flanking plats	43.61	42.43	42.20
	Av. gain from fertilization	1.42	1.83	21.49
1886	Av. 3 fertilized plats	28.44	27.09	45.22
	Av. 5 or 6 flanking plats	27.79	27.19	26.32
	Av. gain from fertilization	0.65	—0.10	18.90
1887	Av. 3 fertilized plats	5.51	6.44	6.97
	Av. 5 or 6 flanking plats	5.80	5.52	5.46
	Av. gain from fertilization	—0.29	0.92	1.51
1888	Av. 3 fertilized plats	54.30	52.40	60.80
	Av. 5 or 6 flanking plats	54.56	54.32	52.08
	Av. gain from fertilization	—0.26	—1.92	8.72
1889	Av. 3 fertilized plats	41.22	36.00	51.19
	Av. 5 or 6 flanking plats	38.99	38.76	38.09
	Av. gain from fertilization	2.23	—2.76	13.10
1890	Av. 3 fertilized plats	32.86	31.25	38.60
	Av. 5 or 6 flanking plats	34.61	34.48	31.62
	Av. gain from fertilization	—1.78	—3.23	6.98
1891	Av. 3 fertilized plats	27.28	25.13	37.45
	Av. 5 or 6 flanking plats	26.20	27.51	27.16
	Av. gain from fertilization	1.08	—2.38	10.29
1892	Av. 3 fertlized plats	24.80	22.55	33.14
	Av. 5 or 6 flanking plats	25.47	25.51	26.17
	Av. gain from fertilzation	— .67	—2.96	6.97

*The minus sign (—) indicates a loss in every case.

The following in table XXII is a summary of the results with, and aggregate results of the ten years trial.

TABLE XXII.

Average and Aggregate Yields of Corn for Ten Years.

Class of Plats.	Bushels per acre.
Average of gas lime plats....................	34.16
Average of flanking plats....................	34.16
Average loss from gas lime..................	.41
Average of phospate plats....................	33.91
Average of flanking plats....................	34.89
Average loss from ammoniated phosphate......	.97
Average of horse manure plats...............	44.74
Average of flanking plats....................	33.57
Average gain from horse manure.............	11.17
Aggregate yield of gas lime plats.............	341.69
Aggregate yield of flanking..................	345.87
Aggregate loss from gas lime.................	4.18
Aggregate yield of phosphate plats............	339.16
Aggregate yield of flanking plats.............	348.92
Aggregate loss from amoniated phosphate.....	9.76
Aggregate yield of horse manure plats........	447.49
Aggregate yield of flanking..................	335.78
Aggregate gain from horse manure...........	111.71

As the effect of the horse manure had not vanished in 10 years, it was decided to continue the experiment with the three horse manure and six flanking plats in order to get the full effect of the manure. The results of the remaining six years to-date are as follows:

TABLE XXIII.

Yields and increase per acre from horse manure applied in 1883 and 1884.

Year	Yield per acre in bushels		Average gain from manure
	Average 8 manured plats	Average 6 flanking plats	
1893	16.76	13.32	3.44
1894	24.63	20.25	4.38
1895	12.85	9.21	3.64
1896	33.50	30.29	3.21
1897	22.88	20.61	2.27
1898	25.68	22.51	3.17

The following in table XXIV is a summary of the results with horse manure for 16 years.

TABLE XXIV.

Average and Aggregate Yield for 16 Years.

Class of Plats.	Bushels per acre.
Average yield of horse manure plats..........	36.48
Average yield of flanking....................	28.24
Average gain from horse manure............	8.24....
Aggregate yield of horse manure plats........	583.78
Aggregate yield of horse flanking flats........	451.95
Aggregate gain from horse manure..........	131.83

The yields of corn stover in this experiment are given below, in table XXV, for eight years for the entire series, and in table XXVI, for 14 years for the horse manure and flanking plats. The crop of stover was not weighed in 1886 and 1887.

TABLE XXV.

Average and aggregate yields of corn stover for eight years.

Class of plats.	Pounds per acre.
Average of gas lime plats..................	2038.08
Average of gas flanking plats................	1985.90
Average of gain from gas lime..............	52.18
Average of phosphate plats................	2152.54
Average of flanking plats..................	1981.93
Average gain from ammoniated phosphate...	170.61
Average of horse manure plats.............	2503.91
Average of flanking plats..................	1952.92
Average gain from horse manure............	550.99
Aggregate yield of gas lime plats............	16304.66
Aggregate yield of flanking plats..........	15887.20
Aggregate gain from gas lime..............	417.46
Aggregate yield of phosphate plats..........	17220.33
Aggregate yield of flanking plats............	15855.50
Aggregate loss from ammoniated phosphate...	1364.83
Aggregate yield of horse manure plats....	20031.33
Aggregate yield of flanking plats............	15623.50
Aggregate gain from horse manure..........	4407.83

TABLE XXVI.

Average and aggregate yields of corn stover for 14 years. — Pounds per acre.

Average of horse manure plats	2274.12
Average of horse flanking plats	1883.95
Average gain from horse manure	390.17
Aggregate yield of manure plats	31837.66
Aggregate yield of manure flanking plats	26375.33
Aggregate gain from horse manure	5462.33

The results of the experiment are summed up in table XXVII.

TABLE XXVII.

Average increase from fertilization.

FERTILIZER	Increase per acre	
	Bushels corn	Pounds stover
Gas lime	*—0.41	52.18
Ammoniated phosphate	*—0.97	170.61
Horse manure	8.24	390.17

*Loss.

Comment on the record of the gas lime and ammoniated phosphate is unnecessary. The results obtained from horse manure are not only very encouraging, but they show clearly the unwisdom of *short* tests of stable manure, as the beneficial effect on the yield extends over many years.

Assuming that the yields of stover in 1886 and 1887 were equal to the average yield of the other years of the test, we find that the horse manure produced an *aggregate increase* per acre of 131.8 bushels corn, and 6242 pounds stover. Reckoning the stover worth $5.00 per ton and the corn 30 cents per bushel, the value of the increase is $55.14.

In view of the probable losses of plant food between crops in the earlier years of the experiment, and the diffusion of the soluble fertility from the manured to the unmanured plats, the results secured, emphasize very strongly the importance of husbanding wisely, and of utilizing fully all the home made manure of the farm.

TEST OF CORN CULTURAL IMPLEMENTS.

By W. C. Latta.

The test of corn cultural implements was begun in 1888 and has been carried on continuously for eleven years. Owing to a severe protracted drouth in 1893 no results of value were obtained for that year.

During the first five years of the test the corn was planted only in drills and consequently the cultivation was "one way" only. In 1893 the plan of the experiment was changed to permit trial of the implement in hill planted as well as drill planted corn.

Since that date the drill has been cultivated one way only as before, and the hill planted corn has been regularly cultivated both ways.

IMPLEMENTS UNDER TRIAL.

Albion spring-tooth cultivator. This is a wheel cultivator with six teeth in each gang. It thoroughly stirs the entire surface to the depth of two or three inches and leaves the soil well pulverized and fairly level.

Corn plow. This is the earliest form of two horse corn cultivator with two hoes or shovels in each gang. This implement does not stir the entire surface nor does it pulverize the soil very thoroughly. It runs deeper than the spring tooth cultivator and throws the soil into furrows and ridges, thus tending to dissipate soil moisture.

The Hoober cultivator. This implement has two blades in each gang and its action is to shave the soil just a little below the surface. It stirs the soil only to a slight depth and it tends to draw the dirt toward the corn rows.

Tower cultivator. This implement shaves the soil like the one just described. It has four blades in each gang and the gangs may be reversed so as to throw the soil alternately to and from the corn rows.

Breed's weeder and harrow. These tools have been used together, Breed's weeder being employed for the first two or three cultivations and the one horse harrow being used for the later cultivation. The action of both these implements is quite superficial.

Hoke cultivator. This is a very high arch cultivator, which adapts it well for the later cultivation. It has four spring teeth in each gang. The points of the teeth are wider than those of the

Albion cultivator, and it therefore throws the soil into slightly larger furrows and ridges than does the latter.

Rock Island disk cultivator. This cultivator effects a thorough stirring,, turning and pulverizing of the soil, but as it had no wheels, the depth of its working could not be controlled. It also ridges the soil along the corn row.

The soil in which the experiment was conducted is a dark colored compact loam, overlying gravel, which gives perfect natural drainage. The soil is indeed too thoroughly drained, as the corn crop is injured by drouth in July or August almost every year.

The soil was broken seven to eight inches deep in the spring of each year. Great care was taken, throughout, to secure uniform soil conditions and to give the plats like treatment in all respects, save the kind of cultivator used.

The time that each implement was under trial and the results as to average yield of corn are shown in table XXVIII.

TABLE XXVIII.

Average yields of corn with different cultural implements.

CULTIVATOR.	Years under trial	Bushels per acre		
		Hill-planted	Drill planted	Average
Albion spring-tooth	5	58.09	54.32	56.20
Corn plow	5	57.27	53.89	55.58
Hoober cultivator	5	54.30	53.27	53.78
Tower's cultivator	5	57.32	54.38	55.85
Breed's weeder and harrow	5	54.53	53.32	53.92
Rock Island disk	4			48.82
Hoke cultivator	1	67.61	69.53	68.57

The uniformity in yields will doubtless surprise many, but this is what one would naturally expect under the conditions of the test. The *prime* condition of a large yield of corn on the Station farm is an abundance of moisture during mid summer, when the crop is making its most rapid growth. Owing to the underlying *deep* bed of gravel there is no reserve of free water below to be drawn upon during drouth; and the amount of capillary moisture that the shallow soil can hold is quite inadequate to meet the demands of a full corn crop. It necessarily follows, therefore, that no matter *what the kind, or frequency* of cultivation, the yield of corn on the college farm must be greatly reduced in dry seasons. On the other hand, the natural fertility and physical condition

of the soil of the Station farm, are such that in seasonable years *any thorough* method of culture which holds weeds in check and keeps the surface soil reasonably mellow will secure a good yeild. It thus apears that there are two leveling agencies at work in the soil of the Station farm, both tending to secure uniformity in yeild regardless of the *kind* of cultivator used. The first of these is a deficiency of moisture in midsummer, which, under existing conditions, no cultural implement can prevent. This is a leveling *down* influence. The second is the excellent chemical, physical and biological condition of the soil in *seasonable* years, which tends to secure a good yield with any reasonably thorough method of cultivation. This is a levelling *up* agency.

It does not follow that the results secured can be duplicated on stiff clay or sandy soils, or even on dark loams overlying *permanently moist subsoils.*

Of the implements under trial, the corn plow (with two hoes or shovels in each gang) and the Hoke cultivator stir the soil most deeply. The former would do considerable root pruning at certain times, if allowed to run its full depth. The aim was to prevent root pruning as far as possible. The Breed's weeder and harrow, and the Hoober are the most shallow working of the implements tested.

The results obtained with corn cultural implements on the Experiment Station farm seem to justify the following conclusions.

1. The *kind* of implement is not so important as thoroughness and carefulness in using the same.

2. In well drained soils, deeply broken and *well filled* with humus, deep culture of the corn crop does not seem necessary at any stage of its growth.

3. Under the conditions which exist on the Station farm, and taking into account ease of working, ready adjustability and thoroughness of work, the Albion spring tooth cultivator has given best satisfaction as a corn cultural implement.

4. It is easy to see, however, that in a different soil, another of the cultivators under trial might give the best satisfaction. The nature and needs of the soil should be intelligently studied and the implement and method of culture should be chosen with special references to the end in view.

FIELD TESTS OF VARIETIES OF WHEAT, COVERING NINETEEN YEARS.

By W. C. Latta.

The testing of varieties of wheat in field trials was begun by the Agricultural Department of Purdue University in 1880, and this work has been carried on continuously to the present.

In all, 178 differently named varieties of winter wheat and 11 varieties of spring wheat have been grown one or more years on the University farm. All but 36 of these varieties have been tested under the present management. Owing partly to severe winter killing, partly to the necessarily small size of some plats due to the very limited amount of seed obtainable, and partly to failure to germinate or grow well, no satisfactory record could be made of the yield of the following named varieties, to-wit:—Red Chaff, Jenning's White, White Amber, Post, Treadwell, Louisiana, Golden Straw, Trump, Rough Chaff, Russian Bearded, Lammas, Nursery, Mediterranean, Muskingum, Armstrong-White Amber, Australian, Many Headed Egyptian, Shumaker, Babcock, Ble de Bordeaux, Ble Victoria d'Automne, Froment Bigarré, Froment Rouge, Apulia, Nol, Kathia, Kujawha.

The spring wheats were grown only one season—that of 1884. They did so poorly that it was deemed unwise to continue the experiment. The results of the trial of spring wheats as to yield are as follows:

TABLE XXVIII½.

NAME OF VARIETY.	Bushels per acre.
Velvet chaff blue stem	Failed
Sibley's black chaff	9.24
Defiance	7.53
Black bearded centennial	Failed
White Russian	11.88
Hallett's original red	Failed
Hallett's Victoria white	Failed
Fultzo-clawson	Failed
Golden grains	Failed
Scotch fife	10.56
Lost nation	12.54

Not only were the yields low, and the grains shrunken, but the chinch bugs were also harbored in damaging numbers.

The following is a complete list of the winter wheats grown, of which yields have been recorded, with their prominent distinguishing characteristics. The yield of each variety, grown more than one year, is the average of the several years grown.

Varieties of winter wheat grown during past 19 years at Purdue, showing average yields.

No.	NAME	Characteristic of variety: Strength of straw	Bearded or smooth	Color of chaff	Color of grain	First year tested	No. years tested	Average yield per acre for years tested. Bush.
1	Amber	Medium	Smooth	....	Amber	1881	3	16.31
2	American Bronze	"	Bearded	White	Red	1892	6	26.29
3	Armstrong	Strong	Smooth	....	White	1881	2	12.20
4	Amerstrong-Diehl-Treadwell	Strong	"	....	"	1881	2	12.42
5	Armstrong-Lancaster	Weak	Bearded	....	Amber	1881	5	24.79
6	Arnold's Gold-Medal	Strong	Smooth	....	White	1882	4	18.08
7	Arnold's Hybrid	Medium	"	....	Red	1881	5	19.20
8	Badger	"	"	White	"	1885	4	31.68
9	Beal	"	Bearded	"	Amber	1892	4	26.08
10	Bearded Winter Fife	Weak	"	"	"	1896	2	23.62
11	Buckeye	Medium	"	....	White	1881	2	14.41
12	Buda Pesth	"	"	White	Red	1898	2	21.00
13	Canada Wonder	"	"	"	"	1893	3	28.48
14	Canadian Hybrid	"	Smooth	"	"	1894	2	30.76
15	Champion Amber	Strong	"	....	"	1884	3	15.55
16	Clawson	Medium	"	....	White	1883	6	26.07
17	Currell's Prolific	"	"	Brown	....	1889	2	31.02
18	Dawson's Golden Chaff	"	"	"	White	1897	3	9.88
19	Diamond Grit	"	Bearded	"	Amber	1896	2	20.06
20	Dibbles's Gold Coin	Strong	Smooth	"	White	1898	1	22.83
21	Diehl	"	"	....	"	1881	2	17.11
22	Diehl Egyptian	Medium	Bearded	....	Amber	1881	7	20.60
23	Diehl-Lancaster	"	"	....	"	1881	7	18.58
24	Diehl Treadwell	"	Smooth	....	White	1881	2	18.78
25	Diehl-Mediterranean	Strong	Bearded	Brown	Red	....	3	23.55
26	Diehl-White Amber	Medium	Smooth	....	White	1881	2	10.12
27	Dietz Longberry	Weak	Bearded	White	Red	1887	9	26.90
28	Dott Red	Strong	"	....	"	1881	5	12.34
29	Early Amber	Medium	"	White	....	1892	1	24.98
30	Early Arcadian	"	Smooth	Brown	Amber	1896	3	10.09
31	Early Genesee Giant	Strong	Bearded	"	White	1894	2	33.76
32	Early Red Clawson	Medium	Smooth	"	Red	1890	6	34.07
33	Early Rice	....	"	....	....	1887	2	21.70
34	Early Ripe	Medium	"	Brown	Red	1898	5	21.01
35	Egyptian	Weak	Bearded	White	"	1881	9	31.39
36	Emporium Scott	Medium	Smooth	....	"	1884	5	22.68
37	European	Weak	Bearded	White	"	1884	7	28.21
38	Extra Early Oakley	"	Smooth	....	....	1896	4	15.09
39	Finley	Medium	"	....	Amber	1884	5	24.09
40	Fulcaster	Weak	Bearded	White	Red	1887	8	27.53
41	Fultz	Medium	Smooth	"	"	1881	12	26.46
42	Fultzo-Clawson	"	"	....	Amber	1894	5	20.40
43	Fultzo-Mediterranean	"	"	White	....	1899	1	12.16
44	Genoese	....	....	....	....	1887	1	2.30
45	German Amber	Medium	Smooth	....	....	1885	4	23.38
46	German Emperor	"	"	Brown	....	1887	4	33.35
47	Gold Dust	Strong	"	White	Red	1886	6	24.75
48	Golden Cross	"	Bearded	Brown	....	1889	4	30.59
49	Haines	"	Smooth	....	Red	1881	3	20.79
50	Hallet's Original Red	Medium	"	White	"	1884	5	28.29
51	Harvest King	"	"	Brown	"	1898	2	16.58
52	Harvest Queen	Strong	"	White	White	1893	4	21.43
53	Hedge's Prolific	"	"	"	Red	1884	7	27.04
54	Hermie's Winter	Medium	"	Brown	....	1890	1	25.21
55	Hicks	"	"	....	....	1885	2	19.86
56	Hickman	"	"	White	Red	1886	3	25.16
57	High Grade	....	"	"	....	1887	2	21.09
58	Hindoostan	Medium	Bearded	Brown	....	1890	1	15.95
59	Home Maker	"	Smooth	"	....	1899	1	19.00
60	Hybride Dattel	"	"	"	....	1891	2	24.79
61	Hybride Larned	"	"	"	....	1891	2	27.76
62	Improved Fultz	"	"	White	Red	1898	3	17.97
63	Improved Rice	Weak	"	"	....	1889	2	29.24

Varities of winter wheat grown during past 19 years at Purdue. (Continued)

No.	NAME	Characteristic of variety: Strength of straw	Bearded or smooth	Color of chaff	Color of grain	First year tested	No. years tested	Average yield per acre for years tested Bush
64	International Club	Strong	Smooth	White	....	1892	2	20.66
65	Johnson	Medium	Bearded	"	Amber	1892	4	26.23
66	Jones' Longberry No. 1	"	"	Brown	"	1898	2	18.62
67	Jones' Winter Fife	"	Smooth	White	Red	1891	6	33.06
68	Kentucky Giant	"	Bearded	"	Red	1894	2	30.91
69	Kentucky White	Strong	Smooth	....	White	1881	2	12.43
70	Long Amber	Medium	"	White	"	1895	8	13.50
71	Long Berry-Red	"	"	Brown	Red	1892	4	26.74
72	Lehigh No. 6	"	Bearded	....	....	1890	2	24.94
73	Lancaster	Weak	"	Brown	Red	1881	7	20.71
74	Landreth	Medium	Smooth	....	White	1884	5	22.14
75	Lovett	Strong	Bearded	....	Amber	1884	8	12.08
76	Martin Amber	"	Smooth	....	Amber	1884	5	22.97
77	McCracken	Medium	"	White	....	1885	4	19.71
78	McGhee's White	....	Smooth	"	....	1886	3	25.54
79	Mediterranean Hybrid	Strong	Bearded	Brown	Amber	1884	2	17.99
80	Michigan Amber	Medium	Smooth	"	Red	1884	16	27.76
81	Michigan Wick	Medium	Bearded	White	White	1882	5	17.53
82	New Columbia	Strong	Smooth	"	"	1898	2	18.83
83	New Hybrid Prolific	"	"	Brown	Red	1898	1	22.50
84	New Monarch	Medium	"	White	"	1887	9	29.65
85	Nigger	"	Bearded	"	"	1886	7	25.01
86	No. 102	Weak	"	Brown	Amber	1896	2	14.72
87	Oakta Chief	Medium	"	White	White	1898	1	16.00
88	Odessa	Strong	Smooth	"	....	1892	1	30.47
89	Ohio Blue Stem	Medium	"	"	Amber	1893	8	24.14
90	Ontario Wonder	"	"	"	....	1889	8	29.56
91	Patagonian Trigo	Weak	"	....	....	1885	4	18.45
92	Pedigree Giant	Strong	Bearded	Brown	Amber	1898	1	20.00
93	Perfection	Medium	Smooth	"	....	1899	1	16.67
94	Perkins	....	"	....	....	1887	2	25.80
95	Poole	Medium	"	Brown	....	1887	4	31.87
96	Powers	....	....	....	....	1881	1	7.01
97	Pride of Genesee	....	....	....	....	1895	1	23.87
98	Pride of Illinois	Medium	Smooth	Brown	Red	1894	2	31.29
99	Raub's Black Prolific	Strong	Bearded	"	Amber	1887	9	29.24
100	Red Cross	"	Smooth	"	....	1899	1	18.67
101	Red Fultz	Medium	"	"	....	1889	8	31.88
102	Red May	"	Bearded	....	Red	1881	6	17.64
103	Red Mediterranean	Weak	"	Brown	"	1884	2	19.63
104	Red Russian	Medium	"	....	"	1881	7	22.76
105	Red Wonder	"	"	White	"	1893	3	26.97
106	Reliable	"	"	"	....	1890	1	27.38
107	Reliable Minnesota	Weak	"	"	Red	1894	2	30.59
108	Rice	Medium	Smooth	....	White	1882	1	23.75
109	Rickenbrode	"	"	....	"	1882	1	19.64
110	Roberts	"	Bearded	Brown	Red	1892	4	23.64
111	Rochester Red	"	Smooth	"	Amber	1892	4	27.46
112	Rogers	....	"	....	"	1881	5	18.13
113	Rudy	Medium	Bearded	White	Red	1892	7	27.37
114	Russian Smooth	....	Smooth	....	....	1888	3	22.15
115	Sandomirka	Strong	"	....	White	1882	1	30.28
116	Shaffer	"	Bearded	....	"	1881	2	14.31
117	Sibleys' Imperial	"	"	Brown	....	1888	2	32.44
118	Silver Chaff	Medium	"	....	White	1881	3	19.47
119	Smooth Scott	"	Smooth	....	....	1885	4	25.80
120	Stock Fife	"	"	White	Red	1893	1	14.33
121	Swamp	"	Bearded	....	Red	1892	1	27.49
122	Tappahannock	"	Smooth	....	White	1891	2	11.27
123	Tasmanian	Weak	Bearded	....	....	1891	4	19.15
124	Tennessee Fultz	Strong	Smooth	Brown	....	1885	1	17.75
125	Theiss	Weak	Bearded	"	Red	1882	4	26.88
126	Tuscan Island Mediterranean	"	"	....	"	1884	3	20.31

Varieties of winter wheat grown during past 19 years at Purdue.

No.	NAME	Characteristics of variety. Strength of straw	Bearded or smooth	Color of chaff	Color of grain	First year tested	No. year tested	Average yield per acre for years tested. Bush.
127	Valley	Medium	Bearded	White	Red	1890	8	26.99
128	Velvet Chaff (Bearded)	"	"	Brown	"	1881	18	26.41
129	Velvet Chaff, Brown (Smooth)	"	Smooth	"	"	1884	7	27.49
130	Velvet Chaff, White (Bearded)	"	Bearded	White	"	1889	6	31.83
131	Velvet Chaff, White (Smooth)	"	Smooth	"	"	1889	5	30.43
132	Victoria	"	"	....	White	1881	2	13.68
133	Washington Glass	"	"	....	"	1882	1	16.66
134	Weedlen	Strong	"	Brown	Red	1892	4	27.83
135	Willits	Medium	"	White	Amber	1892	6	27.36
136	Wisconsin Triumph	"	"	"	....	1892	1	33.09
137	White Bearded Mediterranean	....	Bearded	....	....	1886	1	16.20
138	White Golden Cross	Strong	"	Brown	Amber	1895	2	22.66
139	White Leader	"	Smooth	White	White	1893	1	12.93
140	White Rose	Medium	"	....	"	1881	2	18.06
141	World's Fair	"	"	Brown	Red	1894	2	30.17
142	Wyandotte	"	"	White	"	1886	10	28.56
143	Yazoo	....	Bearded	....	....	1886	3	21.12
144	York White Chaff	Medium	Smooth	....	Amber	1884	3	18.10
145	Zimmerman	"	"	....	"	1882	6	25.16

In recent years it has been the policy of the Department to limit the testing of wheats to a few standard sorts and the newer varieties advertised by seedsmen. A few old varieties are retained from year to year to determine how long the yield and quality can be maintained without deterioration, and to furnish a standard with which to compare the novelties as they appear from year to year. The following are some of the lessons taught by the experiments with varieties of wheat.

1. Varities differ greatly in their hardiness, adaptation to soil, and in their ability to resist scab and rust.

2. All wheats appear to be equally vulnerable to the attacks of loose smut.

3. Varieties of wheat differ much in stiffness of straw, yield and quality of grain, under like conditions as to soil and treatment.

4. The light colored and soft wheats become darker and more flinty as the result of trial on the Station farm.

5. Most wheats do not fully sustain the reputation for prolificacy given them by the seedsmen.

6. Numerous highly prized new varieties do not compare at all favorably with standard well known wheats.

7. All varieties of wheat appear very susceptible to treatment. If neglected they will deteriorate, but they will quickly respond to generous treatment in the way of careful selection of seed, proper fertilization and preparation of soil, etc.

8. Varieties of wheat do not necessarily "run out." Under proper care the yield and quality of acclimated wheats may be maintained from year to year.

9. It is imposible to predict on the record made here, what any given wheat will do in a different soil or in a remote part of the State. In some cases, two wheats do equally well here, when if taken elsewhere vary so greatly that one may prove a decided success, and the other a failure.

10. No "rust proof" or "fly proof" wheat has been found; and none of the wheats tried have been able to pass severe winters uninjured.

FORAGE CROPS.

By W. B. Anderson.

The purpose of this report is to call the attention of stockmen to a number of forage crops, new and old, that may lengthen the pasture season or that may be used as a supplemental forage when drouths make the pastures insufficient to secure profitable returns.

To prolong the pasture season would add millions of dollars to the live stock interests. It would enable the farmer to keep more stock on the same area of land, the by-products of the farm could be better utilized and more manure would be produced and returned to the soil. It would also prevent millions of sheep and cattle from being placed upon the market during the fall months, in an unfinished condition causing a glutted market and falling prices.

Following will be found a list of forage crops that have been grown for several years here and elsewhere in Indiana. Also a number of plants that have been tested at the Station but one season.

Experiments at the Station.

The soil is a dark brown loam, with considerable gravel here and there near the surface. From 12 to 24 inches below, the subsoil consists largely of coarse gravel which gives perfect drainage and in a dry season does not contain sufficient moisture to produce a maximum yield.

The season, however, was a very favorable one and the well distributed rainfall supplied moisture during the greater part of the season.

Breaking and cultivating. The land was broken about eight inches deep, turning under a coating of barn yard manure. A perfect seed bed was made before planting.

The various crops to be tested were planted June 1 and 2, when the ground was warm and full of moisture. Two plats were sown of each variety, using a wheat drill. In sowing one plat, the drill was set at one bushel per acre (drill hoes eight inches apart) every drill hoe sowing, and the other plat was sown with the drill set at two bushels per acre. The two intervening hoes were closed. This gave a distance of 24 inches between the drilled rows.

All plats sown in rows 24 inches apart were cultivated during the early growth of the crop with a spring-toothed cultivator. The plats sown in drills eight inches apart received no cultivation.

Corn.

Common field corn was sown in rows only. It furnished an abundance of forage from August 1 to September 15. If planted early and in successive periods, it can be made to furnish forage from July 15 to October 15.

Stowell's Evergreen] grew well in the cultivated rows, but very poorly in the uncultivated rows eight inches apart. Its rapid growth makes it ready for feeding earlier than field corn. It can be used as a forage from July 1 to August 1. The forage from this crop is well suited to supplement short pastures.

Kafir Corn.

Two varieties of Kafir corn were tested, viz:—Red and White. The growth and yields of the two varieties were apparently the same. The sowing was too thick on both plats to secure the best yields. The stalks were too small to support the heads, hence the crop lodged badly. Kafir corn is not equal to field corn for forage; our stock has not eaten it so well and at the Station farm it yields less per acre. Its redeeming feature is its ability to withstand drouth. It will oftentimes produce a second growth that affords considerable forage. The cultivated rows produced the best yields.

Sweet Sorghum.

The Orange and the Amber varieties were sown. These two varieties are on a par as forage crops. They were also sown too thick unless intended for pasture. The crop lodged badly on both plats. The cultivated rows made better yields than the solid sowing.

All kinds of stock ate sweet sorghum greedily. The early cutting produced a second crop that came into head and almost equaled the first crop in yield. Every farmer in need of a forage crop should give this plant a trial.

Four varieties of sweet sorghum were sent here for trial by the United States Department of Agriculture, Washington, D. C. Because of the small amount of seed sent, the varieties were sown in rows 24 inches apart, at the rate of one bushel per acre. Every variety grew larger and taller than the Orange or Amber, and made much larger yields. The varieties tested are named below in order of yield:—*Coleman's*, *Kansas Orange*, the *M. B.*, and *Folger's Early*. One year's test is not sufficient to determine the compartive merits of these new varieties. Their increased yields

over the older varieties are, no doubt, largely due to thinner sowing of seed.

Dwarf Essex Rape.

This forage has been in somwhat general use in Canada and the northern States for several years. A number of farmers in Indiana report very favorably upon the economic value of this plant. It can be sown as early as the ground will permit in the spring and if a succession of forage is desired through the summer, it may be sown at intervals of two or three weeks, thus furnishing food for the greater part of the season. If sown in July or August, in a good season, it will furnish pasture until a hard freeze kills it, often times until December 15, or even until the holidays. It fills the gap made by drouth in late summer and fall. If cut for soiling or pastured close, it will in a favorable season grow a second or even a third crop without resowing. Like other rapid growing plants, an abundance of miosture is needed, to secure good results. The seed bed should be well prepared and free from weeds. If sown broadcast from three to five pounds per acre are recommended. If a good seed bed and an abundance of moisture are provided the minimum amount is sufficient. Increase this amount if less favorable conditions prevail. The rate per acre when sown in rows varies from one to three pounds. It will usually pay to cultivate the rape, in which case sow in rows 18 to 24 inches apart. The rape may be sown in the standing corn at the time of the last cultivation and thus save expense in the preparation of the seed bed. This plant is especially recommended to farmers growing sheep and swine.

Leguminous Plants.

In estimating the agricultural value of leguminous plants, more must be considered than the yield in pounds of seed, stalk, and foliage. The roots become abiding places for bacteria that are capable of converting inert nitrogen into an available form for plant growth. Again the food contained in the leguminous plants is much more valuable than that found in an equal weight of other plants, as corn or sorghum, because of the greater proportion of protein compounds.

These plants, as rule, do not produce so large a yield per acre as the grain producing plants and are not so well eaten by all kinds of stock.

Soy Beans.

Six varieties were grown at the Station in 1898, with the following results:

Black (Home grown seed). This variety grew 28 to 30 inches high. The solid sowing was equal to the cultivated rows in yield or forage and seed. Since this bean is larger than the ordinary soy bean, the drill should be slightly opened to permit the same rate of seeding. This bean was ripe September 18, and made a fair yield of forage and seed.

Medium Black. The height was 24 to 28 inches. The yield of forage and seed was about the same, on both plats. It was ripe September 18 and produced a good yield of seed and a medium yield of forage.

Early White is valuable as an early bean. It was ripe Aug. 31 Height 18 to 24 inches. It yields a small amount of forage and seed.

Yellow was ripe Septmber 8. Height 28 to 30 inches. The best yields were secured in the cultivated rows.

Edamane was ripe September 15 and produced a good yield of forage, but a poor yield of beans. Height, 34 to 38 inches.

Medium green produced a heavy yield of beans in the cultivated rows, and reached a height of 34 to 38 inches.

Yamagata is very late, and failed to produce a solid bean. It will furnish an abundance of forage and in a favorable season would grow a good yield of beans.

The soy bean has been very favorably commented upon by the Kansas Experiment Station where the bean meal was used in forming a feeding ration for hogs.[5] For every bushel of feed given, the following gains were made:

Kafir corn meal.................................7.5 pounds
Kafir corn meal, 4-5, soy bean meal, 1-5.............12 pounds

"The hogs fattened with soy bean meal have just been marketed, while those not having it will not be ready for *four* or *five* weeks."

Cow Peas.

The cow pea has been grown for three years. Every season an excellent growth of vine was secured. Four varieties were tested in 1898. The yield of seed and growth of vine were decidedly in favor of the cultivated rows. However, if cow peas are grown for green manure, the solid drill sowing would prove preferable, because the vines would be more easily turned under and

[5] Kansas Press Bulletin, No. 24.

a perfect net work of roots would permeate the entire soil. When solid sowing is resorted to, the soil should be free from weeds and in perfect tilth. If a yield of seed is desired, and cultivation can be given, sowing in rows 20 to 24 inches apart will be the better method. The stock on the Station farm cared very little for the cow pea vines. No experiments have been made in feeding the grain. The green stems do not cure readily in this climate and are therefore not so well suited for hay as the clovers. The following varieties were tested:

Wonderful produced a very rank vine growth, especially in the cultivated rows. It would produce an abundance of green forage or green manure. It came into bloom September 18, but failed to produce seed.

Black was very irregular in its ripening—some vines in bloom, others with green or even matured pods. It produces a medium amount of forage. In a long growing season this variety would doubtless produce a fair yield of seed.

Whip-Poor-Will made a fair vine growth and matured an excellent crop of seed. Its rapid growth and early maturity recommend it as a useful variety in this latitude.

Clay made a very poor growth of vine and produced no seed. The plants from the start showed little vitality. This perhaps was partly due to a poor quality of seed. It is inferior to the other varieties as a forage or for seed.

Field Peas (New Varieties).

Two varieties of field pea were tested in 1898. The Idaho was grown the previous year. The Russian was sent there by the United States Department of Agriculture, Washington. D. C., and was given its first trial.

These varieties are far inferior to the soy bean or cow pea. Results of limited tests made with them here, are against their use as forage crops.

Miscellaneous Crops.

Canada field peas and oats have been sown repeatedly in combination and have given very satisfactory results as a forage, both in the green and cured state. The mixture forms an almost "balanced ration", is very palatable and produces heavy yields. It has been tested at this Station and on a number of farms in this State for a number of years. Since oats and Canada peas both are able to stand light frosts without injury, the seed can be sown very early in the spring and will produce a forage for

early summer use. If planted at intervals of about two weeks a succession of valuable forage may be secured throughout the season. If fall forage is desired barley or spring rye should be substituted for the oats.

Any of the mixtures will usually grow on the great variety of soils throughout the state. The land should be plowed deep and all sod or manure well turned under.

After a good seed bed has been secured the oats may be sown broadcast on the ground and followed with a wheat drill. This method places the peas deeper in the ground than the oats and the drill tends to cover the oats near the surface. For two years past on the Station farm we have mixed the oats and peas together, half and half, and drilled them in with a common wheat drill with entirely satisfactory results.

The rate of sowing varies in common practice, according to the nature of the soil and the use for which the crop is intended. If sown on very fertile land and for grazing purposes, 1½ to 2 bushels of each per acre may be sown. If on thinner land, or if intended for soiling purposes and hay, one bushel of peas with one bushel of oats will doubtless give more satisfactory results. This forage mixture should be given a trial wherever a supplemental forage crop is neded.

Vetches.

The Hairy or Sand vetch was tested last season. This variety is an annual leguminous plant, a native of western Asia . It was first introduced into the United States in 1847. It is a trailing herb, one to two feet long. The flowers are purple. The stems are covered with fine hairs. It may be sown in the spring if wanted for summer forage, or if sown in August it will provide late fall pasture and afford very early pasture in the spring.

This plant should be sown with a "nurse crop," as oats, if sown in the spring, or rye if sown in the fall. The nurse crop supports the trailing stems of the vetch and prevents its being injured by coming in contact with the soil. The seed is too high priced to permit the extensive growing of this plant at present.

Co-operative Experiments.

To gather information in regard to the adaptibility of these forage crops in different parts of the State, letters of inquiry were sent out to persons residing in northern, central and southern Indiana. Extracts from the replies are given below:—

FROM C. B. BENJAMIN, LAKE CO. **Stowell's Evergreen,**—"Usually plant about May 24. Estimate yield is 40 bushels per acre. May be fed green and cured for fodder. This is a most excellent feed to tide cattle over a drouth."

"**Canada Field Pea** and oats are sown about April 14, at the rate of one bushel of peas and two bushels of oats to the acre. The yield of grain is about 35 bushels per acre. If cut and cured for hay the yield is usually about two and one half tons per acre. This mixture when fed green or cured for hay, is nearly equal to clover. It is an excellent soil renovator and is very desirable for feed. From my own experience and from that of my neighbors, I can recommend sweet corn, mangels and peas and oats."

FROM CAL HUSSELMAN, DEKALB CO. **Stowell's Evergreen,**—"Usually plant about May 10 at the rate of six quarts per acre. It is fed green on grass and yields 25 to 30 tons per acre. It is the best soiling crop grown on the farm."

"**Grey Eye** and **Early Black** cow peas have been planted from June to August at the rate of 16 quarts per acre. The cow pea has been used for green manure only.

"**Crimson clover** is sown here in July and August at the rate of 20 quarts per acre and is used for a green manure and a clover crop."

FROM J. J. W. BILLINGSLEY, MARION CO. **Stowell's Evergreen** - "Plant as soon as the ground is in suitable condition, following up with another plat 10 days later, and so on, planting at four or five different periods.

"**Sorghum** is planted as soon as the soil is warm enough to secure good germination. The soil, for sorghum, should be well pulverized and free from weed seeds. After the ground is made fine and level, planting is done with a two horse wheat drill sowing about 1¼ bushels per acre. It requires no cultivation, except to pull the large weeds before the sorghum shades the soil. We commence cutting the sorghum when about three feet in height, and later in the season, if a favorable one, the second crop will be quite as good as the first, and the stalks finer.

"Oats and peas have been used for forage, sowing one bushel of peas to 1½ bushel of oats. They grow rank in rich land. The cows will hunt out the oats and leave the peas. Later in the fall, early varieties of corn are planted to give a succession of forage."

FROM D. B. JOHNSON, MORGAN CO., **Canada field peas and oats**—"have been grown here two seasons and judging from their growth they would make an excellent soiling crop, but there is too great a difference in the time of ripening between the peas

and the oats to secure a valuable hay crop. The peas were dead ripe and shelling out when the oats were in condition to cut.

FROM N. D. GADDY, JENNINGS CO., "**Kafir corn** is sown at the rate of one to four quarts per acre and cut for fodder. Corn is better than kafir corn.

"**Soy beans** are sown in May and June, one-half bushel per acre. Estimated yield of seed is 20 bushels and of hay one and one-half tons per acre.

"**Cow peas** are sown here in May and June, one-half to one bushel per acre, and yield about 20 bushels of seed and one to two tons of hay per acre. They are better than soy beans for hay and as a fertilizer. They may be sown in rows, drills or broadcast.

The Whip-poor-will, Black Eye and the **Black** have been tested and usually mature seed. The Wonderful does not produce seed as a rule. For hay, cut when the pods are filled, but before any are ripe."

FROM T. E. ELLISON, ALLEN CO. "Experiments here show the kafir and sweet sorghum to be inferior to field corn.

"**Peas and oats** are grown annually and make excellent hay or may be placed green in the silo. This forage is cut when coming into bloom and produces from six to seven tons of dry hay per acre. There is a great deal of work connected with curing it for hay. It is allowed to remain for a long time in cocks to perfect the curing process."

FROM DR. H. S. WOLFE, FLOYD CO. "**Cow peas** should be planted when the ground is warm and mellow. They may be sown with a wheat drill. The yield of forage may be greatly increased by using fertilizer. Sow one bushel per acre with drill, one-half bushel if planted in rows and one and one-fourth if sown broadcast. Cow peas may be used for pasture, as a hay or a soiling crop. Stock will learn to eat cow peas readily. They equal clover as a fertilizer and are superior to it in low wet lands. Fifteen bushels of seed and two and a half tons of hay are estimated yields per acre. The Black, Whip-poor-will and Clay have been grown.

"The Black is preferred in this locality. No one will go amiss who sows cow peas in any way."

ANALYSES OF FEEDING STUFFS.

By H. A. Huston and A. H Bryan.

Analysis of large green okra seed. Very few analyses of this material are on record. The plant is botanically a near relative of the cotton plant, and since cotton seed is so generally used, it may be of interest to record additional facts about the okra seed.

TABLE XXIX.

SUBSTANCES	Air dry condition. Per cent.	Water free. Per cent.
Moisture	6.45	....
Ether extract	15.98	17 08
Crude protein	22.18	23.70
Crude fibre	23.99	25.64
Ash	4.20	4.49
Carbohydrates	27.20	29.07
Total nitrogen	3.542	3.870
Albuminoid nitrogen	3.350	3.661
Amide nitrogen	0.192	.219
Starch (diastase method)	14.06	14.92
Carbohydrates extracted by 1¼ per cent. sodium hydrate	13.15	14.05

The carbohydrates extracted by 1¼ per cent. sodium hydrate, are determined by making the usual extraction with 1¼ per cent. sulphuric acid, following the ether extraction. The residues, 3 or 4, are dried and weighed, nitrogen determined in 1 or 2 ,and the usual fibre determination completed with the other two. The sum of the albuminoids, and residue from the treatment with 1¼ per cent. sodium hydrate subtracted from the residue from the treatment with sulphuric acid, gives the amount of nitrogen free material removed by the sodium hydrate.

In the case of the okra seed, the sum of this nitrogen free material extracted by dilute alkali, and the actual starch, is practically identical with the "carbohydrates," as determined by difference, indicating that starch was the only carbohydrate removed from this seed by sulphuric acid.

The oil extracted from okra seed failed to react with sulphur, carbon bisulphide and amyl alcohol, the characteristic test for cotton seed oil.

Buckwheat. The following figures in Table XXX, are of a sample of buckwheat.

TABLE XXX.

Buckwheat. Whole grain.

SUBSTANCES.	Air dry condition. Per cent.	Water free. Per cent.
Moisture	9.22	....
Ether extract	2.72	2.96
Crude protein	13.62	14.84
Crude fibre	10.25	11.17
Ash	1.76	1.92
Carbohydrates	62.43	69.11
Total nitrogen	2.18	2.40
Albuminoid nitrogen	1.65	1.82
Amide nitrogen	0.53	0.58
Starch (diastase method)	53.28	58.05
Carbohydrates extracted by dilute sodium hydrate	6.01	7.43
Galactan	0.28	0.30
Pentosans	6.82	7.43

Structurally, the buckwheat plant occupies an intermediate position between plants yielding a high amount of galactan, such as the clovers, and those low in galactan, such as the grasses. Chemically, it does not occupy the same relative position, since the content of galactan is relatively low.

Rauh's Stock Food.

A special cattle food. This is highly nitrogenous food, intended to increase the flow of milk. It is rather unusual, since it contains a large amount of animal matter. It is a mixture of side products of flour or hominy mills, with side products of the packing house in the form of cracklings. The mixture has the odor of the cracklings and the cattle did not take it readily. To remedy this, the manufacturer added some fenugreek.

TABLE XXXI.

SUBSTANCES	Natural condition	Water free
Moisture	11.94	....
Ether extract	9.74	11.05
Crude protein	53.70	60.98
Crude fibre	1.15	1.30
Ash	0.23	0.26
Carbohydrates	23.24	26.41
Total nitrogen	8.56	9.72
Albuminoid nitrogen	7.28	8.27
Amide nitrogen	1.28	1.45
Starch (diastase method)	17.77	20.19
Carbohydrates extracted by 1¼ per cent sodium hydrate	3.96	4.50

This food is very high in both fat and protein. It was tried on an extended scale in a large dairy, but abandoned on account of the general dislike of the cattle for it.

Distillery slop. Table XXXII shows the same composition of a sample of distillery slop sent the Station.

TABLE XXXII.

Distillery slop.

SUBSTANCES.	In original condition. Per cent.	Water free. Per cent.
Dry matter	4.22	....
Water	95.78	....
Ether extract	0.38	9.13
Crude protein	1.22	28.41
Crude fibre	0.29	6.81
Ash	0.02	0.45
Carbohydrates	2.31	55.20
Total nitrogen	.192	4.54
Albuminoid nitrogen	.144	3.40
Amide nitrogen	.048	1.14
Starch (diastase method)	0.63	14.93
Carbohydrates extracted by dilute sodium hydrate	0.38	9.13

It is of interest to note that the diastase method shows considerable starch remaining after the operations of the distillery are completed. A ton of this distillery slop would contain only as much dry matter as one and two-thirds bushels of corn. The proportions of the ingredients, however, are different, since the total protein in a ton of the slop is equal to that in four bushels of corn. The apparent value of this is, however, reduced somewhat by the fact that over one-fourth of the nitrogen is in the amid form and not in the form of real albuminoids.

Comparison of protein content of two samples of corn. A sample of corn was received, for which the grower claimed superior feeding qualities, basing the claim largely on the shape of the kernel. The protein content of this corn was compared with the protein content of a sample of Purdue yellow corn, raised on the Station farm. This corn had a kernel very different in shape. Calculated to dry matter, the corn for which special claim was made contained 12.5 per cent. of protein, while the Purdue yellow contained 12.2 per cent. of protein. As the difference was so slight, no further work was done on the subject. The protein con-

tent of both samples is about two per cent. above the average, for dent corn.

Composition of mangels and of sugar beets. On the Station farm there were raised the past season four varieties of mangels and many varieties of sugar beets.

The use of beets as a succulent food is on the increase, and it may be of interest to compare the mangels with the sugar beet, which latter is also growing in favor as a stock food. Both sugar beets and mangels are subject to a bacterial disease. An analysis of diseased sugar beets of same kind and average weight as sound beets is also included in table XXXIII.

The most notable difference between the mangels and the sugar beets is the amount of water present in the mangels. On the basis of the average dry matter shown in the analysis of the mangels, it would require 2.4 tons of mangels to yield as much dry matter as one ton of sugar beets. Stated in another form, when the farmer harvests a ton of mangels he harvests 1846.6 pounds of water and 153.4 pounds of feeding material; when he harvests a ton of sugar beets, he harvests 1630.2 pounds of water and 369.8 pounds of feeding material. It is cheaper to raise water with a pump than to haul it in from the harvest field and provide storage for it.

It is often stated that mangels contain more protein than sugar beets. These analyses show that the crude protein of the sugar beets raised on the same land is greater than the average protein content of the mangels. Other analyses of sugar beets and mangels show the same thing. Not only is the crude protein of the sugar beets greater than that of the mangels, but the real albuminoids of the sugar beets are 43 per cent greater than are real albuminoids of the mangels. The crude protein of feeding materials is calculated by multiplying the total nitrogen by 6.25. In the case of seeds, no serious error is introduced by this, since nearly all the nitrogen in seeds is in the form of real albuminoids. But in the case of green feeds it often happens that a considerable portion of the nitrogen has not been stored in the form of real albuminoids, but in a form having a lower nutritive value. In the case of beet roots, this difference is greater than in most other feeds, for considerable of the nitrogen is in the form of nitrates, which have no feeding value, but are even injurious.

The reason for the belief that mangels are richer in protein than sugar beets are, has probably been due to a misunderstanding growing out of the fact that the ratio between the protein and carbohydrates is closer in mangels than in sugar beets. This is not due to any deficiency in the absolute quantity of protein

TABLE XXXIII

Chemical composition of varieties of mangel wurzels and sugar beets, in per cent.

SUBSTANCES.	Mangel Wurzles.				Sugar beet, Kleinwanzleben		Mangel wurzels. Water free.				Sugar beet. Water free	
	Golden yellow	Golden tankard	Champion yellow	Mammoth red.	Sound	Diseased	Giant yellow	Golden tankard	Champion yellow	Mammoth red	Sound	Diseased
Dry matter	6.53	8.02	8.37	7.78	13.49	7.05	....	....	......	....	....	......
Moisture	93.47	91.98	91.63	92.22	81.51	92.95	....	....	......	....	....	......
Ether extract (fat)	0.10	0.08	0.70	0.03	0.07	0.04	1.60	1.04	0.93	0.45	0.39	0.58
Crude protein	1.33	1.40	1.70	1.20	1.72	0.61	20.43	17.50	20.44	15.53	9.31	8.79
Fibre	.67	.65	.71	.75	1.35	.77	10.26	8.19	8.58	9.75	7.27	10.96
Ash	.90	.92	1.08	0.88	0.62	0.64	13.83	11.58	12.97	11.34	3.38	9.20
Carbohydrates	3.53	4.97	4.81	4.92	14.73	4.99	53.88	61.69	57.08	62.96	79.65	70.47
Total nitrogen	0.212	0.224	0.272	0.192	0.275	0.097	3.26	2.80	3.27	2.48	1.49	1.40
Albuminoid nitrogen	0.065	0.074	0.089	0.070	0.108	0.067	1.00	0.03	1.08	0.95	0.58	0.96
Amide nitrogen	0.147	0.150	0.183	0.122	0.167	0.030	2.26	1.87	2.19	1.57	0.91	0.44
Starch (diastase method)	0.44	0.91	0.49	0.52	2.02	0.73	6.85	11.39	5.97	6.79	10.98	10.40
Carbohydrates extracted by dilute sodium hydrate	0.24	0.28	0.48	0.34	0.20	0.30	3.47	3.51	5.08	4.22	1.12	4.40
Real albuminoids	0.41	0.46	0.56	0.44	0.68	0.42	6.27	5.83	6.77	5.71	3.68	6.00
Sugar by polariscope	....	....	......	....	14.2	6.9						

in the sugar beets, but to the deficiency of sugar in the mangels.

The regular diastase method gives something which is entered as starch, although it is perhaps doubtful if real starch exists in the roots. It will be noticed that in the case of the sugar beets, where sugar was determined by the polariscope, the sum of the sugar, starch and carbohydrates extracted by sodium hydrate from the residue left on treating with dilute sulphuric acid exceeds the total carbohydrates of the fodder analysis. This is doubtless due to the destruction of some sugar in drying the material. This is a difficulty met with in handling other material; in looking up analyses of tomatoes, for example, a considerable number of cases were found where the sum of the sugar, malic acid and ash exceeded the total dry matter.

In view of the fact that the sugar beets contained 40 per cent. more real albuminoids and 223 per cent. more carbohydrates than the mangels, it would seem that the higher feed value of the sugar beets would more than compensate the grower for the extra cost of harvesting them.

MATERIAL FOR PACKING HORSES' HOOFS.

By H. A. Huston and A. H. Bryan.

This material is said to be a natural product, and is ground and used in the form of a stiff paste. The material in the natural state has much the appearance of soap stone. The color is yellowish green, feel greasy, streak white, and hardness, 1. The analysis in Table XXXIV shows that the principal ingredients of the material are as follows:

TABLE XXXIV.

SUBSTANCES	Per cent.
Water (at red heat	12.20
Silica	59.53
Oxides of iron and alumina	23.20
Calcium oxide	0.68
Magnesium oxide	1.02
Sodium oxide	2.06

There is little iron present, so that the material may be considered essentially a hydrated silicate of alumina.

COMPOSITION OF BONES OF SOUND HORSE AND OF BONES OF HORSE SUFFERING WITH OSTEOPEROSIS.

By H. A. Huston and A. H. Bryan.

Some time ago Dr. A. W. Bitting made an extensive series of invesigations on horses suffering with osteoperosis. In the course of these investigations the samples here reported on were collected. The two animals from which the bones were taken were in fair condition, so far as relates to flesh, but not fat. Their estimated weight was 1175 pounds each. After the animals were killed the bones were well cleaned from flesh and dried for a long period in the air. The weights of the air dried bones were as follows:

	Normal.	Diseased.
Head without teeth	3700 grams	2100 grams
Femur	1575 grams	725 grams
Humerus	1015 grams	650 grams

The humerus of each animal was taken for analysis. The bone of the normal horse was yellowish in color, while that of the diseased animal was grey and very brittle.

The analysis gave the following results, as shown in table XXXV.

TABLE XXXV

Composition of horse bone, per cent.

SUBSTANCES.	Normal bone.	Diseased bone.
Moisture	4.43	6.69
Fat (ether extract)	7.45	0.50
Ossein (nitrogen x 5	16.50	27.00
Other organic matter* (nitrogen free)	15.44	6.31
Phosphoric acid	21.61	23.75
Carbon dioxide	1.30	3.60
Silica	0.13	0.27
Calcium oxide	30.14	31.32
Magnesium oxide	0.45	0.85
Sodium oxide	0.65	0.34
Total	98.10	100.63

*This was determined by subtracting the sum of moisture, ossein and fat from the amount of total combustible matter.

The loss in the case of the normal bone is probably due to failure to obtain all the moisture present. Moisture was determined by drying five hours in hydrogen at 100, C.

While marked differences appear in the composition of the two bones when expressed in percentages as above, the great difference in weight of the two bones of the same size does not permit of a fair opinion being formed of the changes really tak-

ing place in passing from normal to diseased condition. This can be seen better by a comparison of the actual weights of the different ingredients in the two bones, as shown in table XXXVI.

TABLE XXXVI.

Weights of substances in horse bone, in grams.

SUBSTANCES.	Sound bone.	Diseased bone.
Moisture	44.965	43.485
Fat	75.618	3.250
Ossein	167.475	175.500
Other organic matter	156.716	41.015
Phosphoric acid	219.342	154.375
Carbon dioxide	11.195	23.400
Silica	1.320	1.755
Calcium oxide	305.921	203.580
Magnesium oxide	4.568	5.525
Sodium oxide	6.598	2.210

A small gain of ossein seems to have occurred. This, however, may have been due to a modification of the nitrogen content during the changes incident to the disease. Properly speaking, the figures really show a gain of nitrogen equal to 1.54 grams or 0.15 per cent. of the weight of the normal bone. This difference might be found between two sound bones. The most conspicuous changes are in the reduction of the amounts of fat, phosphoric acid, lime, soda and nitrogen free organic matter.

ANALYSES OF MAPLE SUGAR.

By H. A. Huston and A. H. Bryan.

Four samples of maple sugar sent from Lawrence County were examined. Nos. 1 and 2 were made in Lawrence County. No. 1 was rather light color and considered a superior article; No. 2 was also of light color, but rather moist and was made later in the season by the same maker as No. 1. It was of the quality called "sappy." No. 3 was the firm light brown molded cake so common in our markets, while No. 4 was quite dark, soft and of quite different flavor from the others. It was considered of as poor quality as could be found on the market. Table XXXVII shows the results of the analyses.

TABLE XXXVII.

Composition of samples of maple sugar in per cent.

SUBSTANCES.	No. 1.	No. 2.	No. 3.	No. 4.
Moisture	10.34	11.95	8.26	10.50
Ash	1.18	0.90	2.41	0.92
Sugar, direct polerization	85.30	83.30	80.60	61.40
Sucrose (official method)	85.00	82.60	80.00	65.60
Reducing sugars	3.40	3.50	3.20	20.04
Protein (N x 6.25)	......	....	0.30	0.30
Malic acid	......	trace	5.60	2.08

It will be seen that the analyses of Nos. 1 and 2 differ but little, although there was considerable difference in flavor. No 3 is notable for its higher ash and the large yield of malic acid, while the physical qualities of No. 4 are due to the high amount of reducing sugar, due probably to bad management in the process of manufacture.

Accompanying these samples of sugar was a sample of what is known by maple sugar makers as "nitre," or "sugar sand." The air dry materials showed:

Moisture	6.11 per cent.
Organic matter	70.76 per cent.
Ash, not recarbonated	23.13 per cent.

A more extended analysis showed the material to contain

Moisture	6.11 per cent.
Insoluble in water	9.13 per cent.
Reducing sugars	12.74 per cent.
Sucrose	26.88 per cent.
Calcium	12.89 per cent.
Malic acid	20.86 per cent.
Magnesium	trace per cent.
Potash	0.72 per cent.
Protein (N. x. 625)	.40 per cent.

The material is sometimes known as malate of lime.

The malic acid was determined by the method given in Wiley's Prin. and Prac. Agr. Anal., Vol. III, p. 601. The Kayser method given in Allen, Com. Org. Anal., Vol. I, p. 512, proved unsatisfactory in the presence of so much sugar.

Where this "nitre," which is a waste product, has accumulated to any great extent, it ought to be of some value as a source of malic acid.

TESTS FOR THE STRENGTH OF SOLUTIONS OF FORMALDEHYDE.

By H. A. Huston.

The increase in the use of formalin makes a ready means of determining the amount of actual formaldehyde in the solution very desirable.

Allen's Commercial Organic Analysis, 3rd ed., p. 219, states on authority of W. A. Davis, that in solutions of fair purity, the amount of formaldehyde may be determined by the specific gravity. A table is given showing the percentage by weight and volume of formaldehyde present in solutions of various specific gravities. This table has been revised, as the earlier figures were not applicable to the purer solutions sold in the last two years. These figures relate to foreign samples and it was determined to see if they were applicable to goods found on the American market.

For this purpose a number of samples of commercial formalin was purchased and the specific gravity and formaldehyde content determined. For the determination of formaldehyde a number of methods have been suggested. The oldest method is to treat the solution with an excess of ammonia of known strength, and after 24 hours to titrate the excess of ammonia with standard acid. Litmus is the most satisfactory indicator for this purpose. Another method is based on the fact that formaldehyde combines with cyanide of potassium. This method was published by Dr. R. Romijn, in *Zeit. fur Anal. Chemie*, 1897, p. 19. The abstract of it given in *The Analyst*, and as used in Allen, is incorrect and introduces a very large working error. When the original working directions are followed, the method is a very satisfactory one, both in rapidity and accuracy. The above two methods were used to determine the formaldehyde in the samples under consideration.

Table XXXVIII shows the results which were obtained:

TABLE XXXVIII.

Sample.	Specific gravity.	Per cent. formaldehyde by Davis table.	Per cent. formaldehyde by Ammonia method.	Per cent. formaldehyde by Potassium cyanide method.	Retail price per lb.
No. 1	1.077	28.1	35.05	35.44	.45 cts
No. 2	1.075	27.5	36.94	36.69	.60 cts
No. 3	1.061	22.8	35.20	35.06	.65 cts
No. 4	1.084	30.3	37.71	38.41	.45 cts
No. 5	1.093	32.33	37.26	37.86	.50 cts

Samples 1 and 4 were from goods shipped in large demijohns, while the other samples were in the maker's original one pound bottles. All were sold as 40 per cent. solutions.

It is evident that these samples, drawn from five different manufacturers, are of such a character that Mr. Davis' table cannot be used to determine the formaldehyde content from the specific gravity. Of the two chemical methods, Dr. Romijn's studies show that the cyanide method is the better, especially when impurities are present. It is also much quicker and the end reaction is very sharp. It takes but a few minutes to make a determination by this method, and the only standard solution required is an acid solution of nitrate of silver 1-10 normal.

Against this are checked the cyanide and sulpho-cyanide solutions. It will be noticed that none of the solutions contained 40 per cent. formaldehyde. Sometimes the per cent. of formaldehyde "by volume" is used instead of the per cent. by weight. In these samples, numbers 2, 4 and 5 would exceed 40 per cent. by volume.

REDUCING POWER OF TAKA-DIASTASE.

By H. A. Huston and A. H. Bryan.

Taka-diastase has often been used in the place of diastase in the determination of starch, and its use for this purpose has been advocated because it was believed that it would not reduce Fehling's solution, and hence no correction would be required, such as must be found and introduced for every solution of malt. While it is true, a solution of taka-diastase in water does not reduce Fehling's solution, yet a solution of taka-diastase treated in precisely the same way that it would be treated in a case where it was substituted for malt extract in determining starch, shows a marked reducing power. A sample of taka-diastase from Park, Davis & Co., was examined by dissolving 50 milligrams of it in 50 cc. of water, adding 20 cc, hydrochloric acid, s. g. 1.125, and boiling under return condenser for two hours. By this method is was found that 50 milligrams of taka-diastase reduced to cuprous oxide a quantity of copper solution yielding 17.2 milligrams of metallic copper. This quantity is too great to be neglected in starch determinations, yet the constant for a given lot of taka-diastase may be determined once for all, and in this way it provides a reagent far more convenient than malt.

RUSSIAN APPLES IN INDIANA.

By James Troop.

During the extremely cold winter of 1884-5, when the mercury dropped to 34 degrees below zero, many of the fruit trees in Indiana were killed, and people very naturally turned their attention to securing hardier trees, which would stand the extremes of temperature to which it seemed the State had become subject.

About that time the experiments of Prof. J. L. Budd, of the Iowa Agricultural College, with the *Russian* fruits, were beginning to attract attention, and so it was decided to plant an experimental orchard, which would consist for the most part, of the Russian varieties, for the purpose of securing a hardy class of trees, and also determine whether or not these foreign winter varieties would be adapted to a climate so far south. It was argued that many of these varieties were found growing in their native country where the climate was about equal to that of Indiana. It was known that a few summer and fall varieties had been imported 30 or 40 years before, and were classed among our standard varieties. The most common among these were the Red Astrachan, Oldenburg, Alexander, Fameuse, and Tetofsky, all well known varieties and grown extensively at the present time, both for market and culinary purposes.

In the spring of 1886, about five acres were planted to apples, pears, plums and cherries, the greater portion of the trees coming from the importations of Professor Budd. In 1888, about 200 more trees, from the same source, were set out. Although the soil and climatic conditions of the college farm are unfavorable for an apple orchard, these trees have nearly all made a vigorous growth, and the most of them have been in bearing for several years. Although we have not had such another severe winter as that of 1885 since the trees were planted, yet we have no reason to doubt that they will stand any amount of cold that we are likely to have, in this section of the country at least.

The trees, as a rule, are all right, but when fruiting time came, our expectations were not fully realized. We had hoped to find a few varieties, at least, that would prove themselves to be good keepers, and that could be substituted for some of our tender native varieties, but not one variety in the whole list can be classed as a winter apple in Indiana.

Description of varieties fruiting the present season.

Arabka This variety makes a good appearance in the orchard, making a vigorous growth, with a low and spreading

head. The fruit is medium to large, having the bloom and general appearance of the Blue Pearmain. The quality is only medium, and rather tart, until fully ripe. It would probably do pretty well as a late fall market apple. It will not keep, however, later than November, unless kept in cold storage.

Antenovka. Tree upright, fruit large, yellow, very showy, and for that reason would sell well in the general market. The quality, however, is only medium, not so good as our Wealthy, but ripening about the same time.

Bogdenoff White. The tree is somewhat spreading in habit, making a good, vigorous, hardy growth. The fruit is quite large, yellowish white, crisp, sub-acid, and of very fair quality. Ripens in September.

Boiken. This was one of the first varieties to begin bearing in 1891, and has borne more or less fruit every season since. In fact, it is one of the most productive varieites in the whole list. The tree is low and quite spreading, with rather slender branches, necessitating severe pruning, if it is desired to keep the orchard cleanly cultivated. Fruit large, greenish yellow, with splashes of red in the sun. Flesh moderately tender, sub-acid and of fairly good quality, especially for culinary purposes. Professor J. L. Budd, of Iowa, states that this apple ought to keep well into winter in Central Indiana, but we never succeeded in keeping it later than November.

Bogdenoff. Tree spreading, fruit large, smooth, green, somewhat russeted and slightly striped in the sun.

Cross. Tree moderately spreading, fruit medium to large, oblate, striped, of fairly good quality.

Champagne Pippin. Tree upright, somewhat spreading, fruit large, oblate, striped, a very desirable early apple, as it makes a good appearance in the market.

Danziger Kantapfel is a spreading tree, fruit red, medium in size, and of fairly good quality, keeps well into fall.

Erdber's Striefling is medium in size, oblate-conical, red in the sun. Tree spreading in growth.

English Pippin is much like Longfield in size and appearance, but the tree is more spreading in habit and makes a more vigorous growth. It is an annual bearer of a rather small, handsome apple, which is fine for culinary purposes and fairly good for desert.

Fameuse. This old variety is better adapted to the climate of Michigan than Indiana, especially the south half of the State.

It is a very desirable desert apple, when well grown, but being subject to the apple scab, it needs a thorough spraying.

Great Mogul, Tree spreading, fruit large, oblong-flattish, greenish yellow in color. Rather shy bearer.

German Calville. Tree an upright grower, fruit large, greenish white. A handsome apple, but rather poor keeper.

Grandmother. makes an upright growth, fruit quite large, slightly conical, yellow, of good quality, season September.

Hibernal is spreading in habit of growth, a great bearer of large even sized, handsomely colored fruit, which is very good for culinary purposes.

Himebeer. Tree spreading, fruit medium size, conical, early.

Kiev Reinette. Tree spreading, fruit large, flat, green striped in the sun.

Kremer's Glass. Tree upright in growth, fruit large, yellow, quite acid until fully ripe, which is the last of July or the first of August.

Lead. Tree upright, fruit large ,oblate, conical, yellow, with blush in the sun. A good cooking apple.

Longfield. This is an annual bearer of medium to small size, yellow fruit, handsomely blushed in the sun.

Monegi. Tree an upright, somewhat spreading growth, fruit large, flat, striped, of very good quality.

Melonen is an upright tree, fruit medium in size, oblong and slightly conical at both ends, delicately striped, and good for desert.

Oldenburg. This variety is well known as the Duchess of Oldenburg. As a summer apple, it holds a prominent place in the orchard.

Pink Anis is an upright grower, fruit medium in size, conical and slightly striped in the sun.

Painted Pipka. Tree spreading, fruit large, conical, striped. an early apple of rather poor quality.

Posart's Nelivia is an upright grower, fruit medium in size, oblong, flattish, white.

Red Anis. Tree spreading, fruit large, oblate-conical and red all over in the sun. Only medium in quality.

Red Astrachan. One of the most commonly grown and best known of our summer apples.

Red Repka. Spreading tree, fruit small, conical, and red in the sun. Of not much value either for desert or market.

Red Sport. Tree upright in growth, fruit large, oblate, red, of fairly good quality.

Red Stellmar. Tree spreading; fruit medium in size, striped with red, early.

Red Jungferm. Tree upright, of slow growth; fruit medium in size, oblong, conical, red. Only medium in quality.

Red Queen. Tree spreading; fruit large, oblong, conical, striped, early.

Reinett is an upright spreading tree, fruit large, oblong, flattened. Yellow with a slight blush in the sun. Quality below the average.

Red Transparent. Tree is a slow grower, spreading habit, fruit much the shape of the Yellow Transparent, but not so good in quality nor so attractive in appearance.

Red Beitigheimer. Tree spreading, fruit large, oblong-flattened, red, a poor keeper.

Romna. Tree spreading, fruit medium in size, handsomely colored. Quality good for cooking.

Rosenhager. A vigorous, spreading tree, fruit large, oblong, dark red and a late keeper, keeping well into the fall.

Thaler. Tree upright, somewhat spreading, fruit a little larger and later than Yellow Transparent, but in other respects much like it.

Titovka. Tree somewhat spreading in growth, fruit medium to large, oblong-conical, very highly colored in the sun. More attractive in appearance, but not as good in quality as Benoni.

Tetofsky. An upright grower, fruit medium to small, striped, nearly red in the sun, early and of fairly good quality.

Tyrola Tauben. The scions from which this tree was raised were received from Russia in 1888. The tree is an upright, somewhat spreading grower, fruit medium in size, and very pointed, unlike any other variety on the list, green, with slight blush in the sun, quite late keeper and quality only fair.

Winter Striefling. Tree spreading in growth, fruit large, oblate-conical, striped, very handsome, and of fairly good quality.

I have already top worked a large number of these trees to other varieties, among them being 45 varieties, the scions of which were received from the Department of Agriculture, and 20 varieties received from the State of Washington.

The list of plums and cherries remains the same as given in the report for 1896, and the notes given at that time will still apply.

EXPERIMENTS IN FORCING VEGETABLES.

By James Troop.

In 1898 the first series of experiments were carried on in sub vs. surface irrigation of lettuce and tomatoes. The beds for tomatoes being four and one-third feet wide by 25 feet in length. One of these was lined with zinc, and a layer of soft brick, leaving a space of five inches above the bricks for soil. Water was applied from below. The other was five inches deep, filled with soil and watered entirely from the surface.

The beds for lettuce were of the same dimensions and arranged in the same manner, and the water applied as in the case of the tomatoes.

During the winter of 1899, the same beds were used and also an additional bed watered by means of a coil of water pipes punctured at intervals of 18 inches with small holes for the distribution of water which was forced through the pipes by means of a hose attached to a hydrant. While the results of this method were very satisfactory, they were not entirely so, the water not being distributed so evenly as in case of the soft bricks. While the results of the first trial were decidedly in favor of the sub-irrigated plants, the results during the present season in the tomato test show a larger yield in ounces per plant as well as a larger number of fruits per plant on the surface irrigated bed. This holds true with both varieties used, viz: Lorillard and Stone.

In the experiment with fertilizers in varying amounts upon lettuce in the forcing house, the bed was divided into five plats, ordinary garden soil being used, and the following amounts of fertilizers used on each plat:

Plat 1.—One ounce nitrate of soda; two ounces acid phosphate; three ounces ground bone and one ounce muriate of potash.

Plat 2.—One ounce of nitrate of soda; two ounces of ground bone; one ounce of muriate of potash.

Plat 3.—Two ounces ground bone; one ounce muriate of potash.

Plat 4.—One ounce nitrate of soda.

Plat 5.—No fertilizer.

Weight of plants Feb. 12.

Plat 1.—59½ ounces.

Plat 2.—71½ ounces.

Plat 3.—63 ounces.

Plat 4.—64 ounces.

Plat 5.—60 ounces.

An accident to a single plant in plat 1, caused a falling off in the weight of that plat.

Experiment with fertilizers on peas, sowed June 10.
Fertilizers used.

Plat 1.—Three ounces of nitrate of soda; six ounces ground bone; three ounces muriate of potash.

Plat 2.—Six ounces acid phosphate; six ounces ground bone; three ounces nitrate of soda.

Plat 3.—Three ounces muriate of potash; three ounces nitrate of soda.

Plat 4.—Without fertilizer.

Average height of vines Jan. 23, 1899.

Plat 1.—Nine inches.

Plat 2.—Eight and one-half inches.

Plat 3.—Eight and one-fourth inches.

Plat 4.—Eight inches.

Weight of pods.

Plat 1.—Four rows, 17¾ ounces.

Plat 2.—Four rows, 22¾ ounces.

Plat 3.—Four rows, 17½ ounces.

Plat 4.—Three rows, 9¾ ounces.

Weight of vines.

Plat 1.—Four rows, 22 ounces.

Plat 2.—Four rows, 22 ounces.

Plat 3.—Four rows, 19 ounces.

Plat 4.—Three rows, 8¼ ounces.

CORN SMUT.

By J. C. Arthur and Wm. Stuart.

GENERAL INTRODUCTION.

Every farmer in Indiana is thoroughly familiar with corn smut. It is a disease occurring to some extent wherever Indian corn is grown, in the old world as well as in the new; but it appears to be especially abundant and harmful in Indiana and some other middle western States.

Unlike the smut of the smaller grains, that of corn may show upon any and every part of the plant above ground. In estimates made in 1895 in fields of several acres near the Experiment Station the percentage of plants showing smut ranged from 5 to 12, as shown in table XXXIX, with only between one and two per cent of the ears destroyed. These figures appear to represent about the abundance of corn smut in ordinary years througout the State.

This is for dent corn; sweet corn is usually more susceptible to the disease, although a late planted field of Stowell's Evergreen, near the Station, surrounded by fields of dent corn, proved to be very low in smut (see table XXXIX) in a count made in 1895. Reports have come to the Station a number of times regarding severe injuries to sweet corn, but it has not been possible to secure exact data. A correspondent in Northern Indiana recently wrote to us, saying: "We have a very early and choice kind of sweet corn, which we have been growing for several years; but during the last two or three years the smut has been increasing on the ears, until last year (1898) the corn was almost worthless." In Iowa, a loss of as much as two-thirds of a crop has been recorded.[1]

Confining ourselves to the common field corn of this State, which is nearly always some variety of the dent group, flint corn being little grown, it may be stated with every likelihood of meeting the views generally held by farmers, that the smut of corn is a prevalent disease, that it causes some loss of the crop every year, that the loss is occasionally considerable, and that at all times its presence in the corn field is objectionable. If we assume that only one ear in two square rods is destroyed, it will mean a loss of about one per cent., which is probably a low estimate for the State, and especially low for some sections of it. Taking official statistics as a basis, the yield of corn has been a

[1] Bessey, Bull. Neb. Exper. Sta., No. 11, p. 17. 1889.

little over 30 bushels to the acre for Indiana (1887-1897), which may be fairly valued at 33 1-3 cents per bushel, or $10.00 per acre; although it is to be remembered that in some of the more fruitful counties the returns are much larger than this. If we assume the low estimate of one per cent. of loss of ears by smut, it amounts to ten cents per acre, or a total of over $375,000 a year on an average for the whole State. The real loss is probably twice as great as this, or more, at least for most years, but the intention is to use figures well within the actuality. To this estimate we must add the loss which comes from the weakening of the plants, and the consequent decreased yield when the smut develops upon other parts of the plant beside the ear, which is often doubtless considerable. Furthermore, some account is to

TABLE XXXIX.

Percentage of smutted plants in corn fields near LaFayette, Ind., in 1895.

	Late planted sweet corn unmanured Sept. 8.	Late planted dent corn unmanured Sept. 10.	Early planted dent corn manured Sept. 19.
No. stalks counted	5000	4647	2482
No. stalks smutted	153	266	298
Percentage	3.06	5.72	12.01

be taken of the possible injury to stock from eating the smutted fodder. Altogether, from these facts, we may safely conclude that the farmers of the State will find it to their interests to examine this subject and take suitable precautions against the pest.

There is but one kind of corn smut occurring in the State, although other kinds are known elsewhere. It makes its appearance on any part of the plant above ground, from the time the plant is six inches high to maturity, but is most noticeable and injurious when in the ear. The disease first shows as a swelling that becomes pale and watery as it grows, and is soon covered with a thin white membrane. As the spores begin to ripen, the interior becomes blackish, and finally the whole mass turns to a black powder, loosely held in place by a small amount of fibrous material. The smut masses, or pustules, range from an inch or two in diameter on stalks, leaves and tassels, to six or eight inches in diameter, being largest on the ears.

The smut disease is due to a parasitic fungus, whose thready

growth ramifies among the tissues of the corn plant, absorbs its sap, and through irritation of the parts causes an abnormal pustular development. When the fungus matures it is almost wholly converted into innumerable spores, individually microscopic, but together forming quantities of a greasy black powder. These powdery spores propagate the disease from year to year.

INITIAL EXPERIMENTS TO PREVENT SMUT.

The prominence of corn smut early induced the Botanical Department of the Station to examine into the probability of discovering some preventive or palliative remedy for it. From the general similarity of the smuts of oats and wheat to that of corn it was a natural inference, afterward found to be entirely fallacious, that what would prevent smut in the small grains would also do so in corn. Therefore, when the Jensen hot water method for preventing cereal smut was being studied, its application to corn was also thoroughly tested.

TABLE XL.

Treatment of seed corn with hot water to prevent smut.

TREATMENT.	Planted May 14, 1891.			Planted May 25. 1891.		
	Total No. of plants.	No. of smutted plants.	Per cent of smut.	Total No. of plants	No. of smutted plants.	Per cent of smut.
Sum of controls	1408	148	10.51	1499	49	3.27
51°C. (125°F.) 5 min. .	128	17	13.28	81	1	1.23
51°C. (125°F.) 10 min. . .	121	19	15.70	80	2	2.50
54°C. (130°F.) 5 min . .	135	15	11.11	84	4	4.76
54°C. (130°F.) 10 min . .	127	16	12.59	80	4	5.00
57°C. (135°F.) 5 min. .	125	8	6.40	83	1	1.20
57°C. (135°F.) 10 min. . .	120	9	7.50	84	0	0
60°C. (140°F.) 5 min. . .	127	14	11.02	82	3	3.66
60°C. (140°F.) 10 min. .	123	15	12.19	82	5	6.09
63°C. (145°F.) 5 min. . .	121	17	14.05	82	4	4.88
63°C. (145°F.) 10 min. . .	81	8	9.88	51	1	1.96
66°C. (150°F.) 5 min. . .	No	re-	cord	161	5	3.11
66°C. (150°F.) 10 min. . .	No	re-	cord	39	1	2.56
69°C. (155°F.) 5 min. . .	90	7	7.78	76	1	1.31
69°C. (155°F.) 10 min. . .	26	2	7.69	25	0	0
71°C. (160°F.) 5 min.	3	0	0	12	4	33.33
74°C. (165°F.) 5 min. . .	1	0	0	0	0	0

The supposition was that if smut in oats and wheat could be prevented by treating the seed grain to a bath in hot water at a temperature that would kill the smut spores and leave the grain uninjured, the same could be done with corn, and that it only needed a series of experiments to ascertain the required temperature. Although it was afterward found out that this procedure

was futile in the case of corn, because the fungus never gains entrance to the plant from spores attached to the seed planted, but from spores blown through the air, yet it is thought best to record some of the data of these experiments in order to convince persons who may still be skeptical regarding the finality of the conclusions. Table XL gives the results of two experiments conducted in 1891. The corn selected was an early yellow dent variety, part of the seed used on the Station farm, and not more contaminated with smut than the average crop of the region. The seed was enclosed in muslin bags and held in water at different temperatures ranging high enough to exceed the death point for corn. Although no tests of the death point for the smut spores have been made by this Station, yet from subsequent researches conducted in Iowa[a] it is certain that the range selected for the experiments exceeded the death point for the smut, and furthermore exceeded that for corn. The ground used for the experiment had not been in corn for several years. The smutted stalks were counted on August 18 and 19. A study of table XLI will show, we think, that the planting of seed free

TABLE XLI.

Summary of treatment of seed corn in 1891 with hot water.

	1st planting per cent. smut in the crop.	2nd planting per cent. smut in the crop.
Untreated seed	10.51	3 27
Treated with hot water	11.07	3 27

from viable smut spores did not in the slightest degree reduce the amount of smut in the crop. As nearly the whole range of treatment was above the death point for the smut spores, we may fairly contrast the results from the treated and the untreated portions. In the first planting 11.07 per cent. of the plants developed smut in the treated portion and 10.51 per cent. in the untreated; in the second planting 3.27 per cent. showed smut in both the treated and the untreated portions; that is, there was no appreciable difference between them.

[a]Stewart, Proc. Iowa Acad. Sci. for 1894, 2 : 76. Spores of corn smut immersed in water for fifteen minutes lost their power of growth at 52°C. and above, and corn under same conditions did not germinate from 71°C. upward.

It was also found by trial in 1891 that seed corn taken from stalks which were infested with smut, but not in the ear, gave a crop no freer from smut than corn from stalks harboring no smut. (See table XLII.) It was further ascertained at the same time that the amount of smut in the crop could not be increased by sowing smut with the seed. The seed in this case had a mass of spores applied to the germ side of the kernel before planting, and made to adhere by moistening with starch paste.

TABLE XLII.

Seed from smutted stalks and clean seed with smut spores applied, 1891.

SOURCE OF SEED AND TREATMENT.	Total No. of plants.		No. of smutted plants		Per cent of smut.	
	Planted May 14.	Planted May 25.	Planted May 14.	Planted May 25	Planted May 14	Planted May 25.
Seed from stalks free of smut, untreated	123	76	20	0	16.26	0
Seed from stalks free of smut. 69°C., 5 min	98	75	10	0	10.20	0
Seed from stalks with smut, untreated	135	87	22	5	16.29	5.75
Seed from stalks with smut, 69°C., 5 min	90	71	14	2	15.56	2.82
Seed in water. 69°C., 5 min., then coated with spores	92	131	10	8	10.87	6.11
Seed in water. 69°C, 10 min., then coated with spores	......	31	......	5	.....	16.13

Another trial was made in 1895 to control the smut by treatment of the seed, and with the same results as before, as may be seen by examination of table XLIII. In this and in the former trial it seemed as if the hot water treatment of the seed encouraged the smut, rather than decreased it. In the 1895 experiments an attempt was made to put the question of the infection of the seed beyond all doubt by applying spores in a germinating condition. A Pasteur sugar solution, well thickened with smut spores, some of which had begun to grow, as shown by the microscope, was used to coat the kernels of corn before planting. It was somewhat sticky on account of the sugar, and adhered well to the grains. The record shows (table XLIII), that under the most perfect conditions we could devise no evidence of infection followed.

TABLE XLIII.

Treatment of seed in order to increase or decrease smut in the crop.

TREATMENT OF SEED.	No. of plants.	No. plants smut'd	Per cent. of smut.
Untreated	335	47	14.0
1 lb. copper sulfate in 15 gal. water for ½ hour	295	41	13.9
Ammoniacal cupric carbonate for 1 hour	256	27	10.5
Water at 60°C. (140°F.) for 5 minutes	287	42	14.6
Pasteur solution containing germinating corn smut spores	268	36	13.4

When we take into account the ineffectual attempts to infect the corn plant with smut through the planted seed, and the equally ineffectual attempts to secure disinfection by treating the seed with fungicides, there can remain no doubt that smut attacks corn in some other way than through the seed or seedling. Others[3] have tried similar experiments, of which the best known are probably those conducted at the Wisconsin Station in 1883[4].

These details and results of experiments have been recorded in order to impress the reader beyond the probability of forgetting, that unlike the case of oats and wheat, corn smut can not be reached by treatment of the seed.

[3] Henry, Rep. Board of Regents Wis. Univer. for 1881: 46-54. 1882.
Satterlee, Mich. Agr. Rep. for 1883: 45. 1884.
Pammel, Proc. Iowa Acad. Sci. for 1891, 1: (Pt. 2) 95. 1895, and Bull. Iowa Exper. Sta. No. 20: 726. 1893.
Buckhout, Rep. Penn. Exper. Sta. for 1891: 179-180. 1892.
Kellerman, Bull. Kans. Exper. Sta. No. 23: 101. 1891.
Georgeson, Bull. Kans. Exper. Sta. No. 30: 202. 1891.
Goff, Tenth Rep. Wis Exper. Sta. for 1893: 246. 1894.
Halsted, Rep. N. J. Exper. Sta. for 1896: 352. 1897.
Selby & Hickman, Bull. Ohio Exper. Sta. No. 78: 92. 1897.
Thomas, Proc. Ind. Acad. Sci. for 1898: 62-64. 1899.

[4] Henry, First Rep. Wis. Exper. Sta. for 1883: 25-27. Seed was prepared in three ways: with copper sulfate, and with carbolic acid, and with smut spores placed in the hill with the seeds. There was no apparent effect upon the amount of smut in the crop.

EXPERIMENTS OVER A HUNDRED YEARS AGO.

Among the earliest references to the subject of corn smut is the record of studies and experiments by Tillet[5], who in 1760 and 1761 made a careful investigation of the disease in the fields of Angoumois, a province in southwestern France. The wheat fields of that region had been devastated by insects, and two members of the French Academy had been designated to look into the matter. They were the distinguished botanist and forester, DuHamel, a man 60 years of age, and author of a number of important treatises, and Tillet, a much younger man. The study of corn smut was an unexpected side issue. But both men were readily interested in the subject, for DuHamel had already called the attention of others to it, and Tillet five years before had published a hundred and fifty page work on the cereal smuts. After a preliminary survey, DuHamel returned to Paris and left the field work to his younger associate.

It seems strange in this day to read in Tillet's report to the French Academy the grounds on which he thought it necessary to apologize for giving attention to such a matter. "I admit," he says, "that the corn or Turkey wheat, a disease of which I am about to describe, is not often cultivated except for animals but it frequently happens that want or poverty compels the peasants to seek nourishment from it; and is it not a good idea to give attention to this kind of grain, since it contributes to the sustenance of a portion of the people that the government itself holds an interest to preserve?" He continues in this conciliatory strain by saying that the peasants rarely use any of the wheat they raise, "being too precious for them;" and we wonder at the changes that a hundred and forty years have wrought. Late statistics show that in the year 1898, the United States have produced 2,000 million bushels of corn, against 675 million bushels of wheat, with a prospect of these figures being exceeded in the present year of 1899, and that the corn had much the greater value in money and in general utility. Every one eats wheat now, even the poorest, and also every one eats corn, even the richest. Furthermore, vegetable pathology no longer needs defense, and men of learning under the direction of the government may openly devote themselves to the study of plant diseases even in cases where no practical advantage is clearly observable.

Tillet gives a very graphic account of corn smut, which would apply in every detail to the appearance of the disease as we know it in our fields today. But it is Tillet's experimental studies that

[5] Mem. et Hist. Acad. Sci. for 1760:85-89,254-261.

stand out most prominently; they were so well devised and so conclusive that had we read the account there would have been no need for the work which has been tabulated and summarized above, except as confirmation; the problem had been settled 138 years ago. It must be borne in mind that the stinking smut of wheat was at that time well known to be due to the spores that adhere to the seed grain, and the practice was common among farmers to treat the seed with some solution to remove or kill the spores. This knowledge was the basis for work on corn smut. The account may best be given to some extent in the words of Tillet,[6] as closely as an English rendering permits.

"To the house where I was lodged in Rochefoucault was attached an ample garden, very well exposed, the soil of which was good, and where there was a small piece of fine wheat, while another part was planted to legumes or bore fruit trees. I enclosed a small piece in a corner of this garden, in order to perform some experiments I had in mind. I divided it into three plats or strips, each of which was about six feet wide by eighteen feet long; they were separated by a path two feet wide, and each plat was marked off the longest way into seven rows, one foot apart."

In the first eleven of these twenty-one rows he planted kernels of corn that "he had kept for a long time in the black dust with which the excrescences, caused by the disease, are filled; these grains were so well covered with the dust, that when they were planted some of it fell off and lay in the bottom of the furrow where the germ would develop." The next four rows were planted with corn "which at first had been thus inoculated, but which I had washed before planting in a lye-wash that I had made from dissolved lime, as it is the custom of practical men today in the preparation of their wheat." The next row was planted with kernels from the tip of ears where they were black and seemed to indicate a beginning of the disease. Three more rows "were planted with sound grain, to which I had given no treatment." Finally the two remaining rows were planted with corn that "came from an ear partly sound and partly spoiled."

In connection with this carefully planned experiment, he instituted another by selecting from a field not far away young corn plants "that appeared to me the feeblest, or those which were darker in color than the others," as indicating some tendency toward the disease. These were transplanted to his garden, and by watering were but slightly checked in their growth.

[6] Tillet, Hist. de l'Acad. roy. des sciences; annee 1760: 258. Paris, 1766.

The results were not at all what were expected. "I have constantly kept my eyes upon the plants which were in my experiment," he says, "and I have taken occasion every day to go into the open fields to make comparison with those which I have just examined. I carefully observed in scrupulously visiting each of the plants, the least alteration or the most trifling blemish that could be found, in hopes that some one of them would aid me to detect the beginning of the disease." And yet he says, "I did not notice the slightest protuberance in the large number of plants that my three plats contained; and among those that were transplanted only one plant bore on the midrib of one of its leaves a beginning of the disease." Even this one protuberance made but a slight development, and proved abortive.

No fault can be found with these experiments; they were as well planned and executed as if performed by a modern experiment station. But the conclusions drawn by Tillet and subsequent writers were wholly unwarranted. "Therefore," he says, "it appears from these experiments that the black dust into which the excrescences are converted is not contagious, and that the kernels of corn with black tips that have begun to change do not contain the principles of the disease." The opinion of this experimenter was adopted by many writers, the leaders undoubtedly being **Beckman**[7] of Gottingen, **Imhof**[8] of **Strassburg**, and **Parmentier**[9] of **Brussels**, and thus **because** a **part of cyclopedic** knowledge.

What the experiments of Tillet did prove was that the smut disease of corn is not transmitted through the seed or seedling; but as he had asserted that it was not transmitted by the spores, an entirely unwarranted and false conclusion, it was necessary to furnish some other explanation of the phenomenon. Although some writers, including DuHamel, ascribed the swellings to the sting of insects, yet Tillet opposed this view on good grounds, but thought them due to "a too great abundance of sap, which in rich land is carried toward certain portions of the plant, with more force than demanded by the natural texture of the plant, and causes an excessive dilation in the utricles or cellular tissue of the parenchyma." He thought it was a physiological

[7] **Hannoverisches Magazin 6** : 1339. 1768.

[8] Zeae Maydis morbus ad Ustilaginem vulgo relatus: 12. Argentorati, 1784.

[9] **Le mais ou blé de Turquie, Mem. Acad Bordeaux.** 1786.

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A B

SMUTTED CORN PLANTS.

A shows four pustules of smut, each at a node of the stalk. The smut has attacked the stalk at the base of each joint, inside the sheath, and after a time the pustule has become so large as to burst the sheath.

B shows a large pustule at the uppermost node of the stalk, which instead of bursting the sheath has pushed the tassel bearing stem over to one side. All the stem within the upper sheath was affected, but chiefly at the node.

disease, not a parasitic one. The excessive sap theory was largely accepted for many years, and it would not be difficult to find advocates for it even now.

EARLIEST MENTION OF CORN SMUT.

Corn is a native of America, probably of Mexico. The explorers of America found it in cultivation by the natives over a territory extending to the LaPlata river in South America and far northward in the United States. It was probably introduced into Europe shortly after the discovery of the new world by Columbus. Spanish records [10] show that corn was sent to Seville as early as 1500; and it was doubtless rapidly disseminated, although not extensively cultivated, for it is mentioned by many authors in the first half of the 16th century.

It would seem that excrescences so conspicuous and peculiar as those of the smut disease of corn would attract the attention of writers, and yet this is offset by the fact that early writers were not likely to attach much importance to the abnormal growths of plants. The earliest American record of the disease we have found is by Schweinitz [11] in 1822, who was in fact the first North American botanist to systematically collect and record fungi occurring in the United States. It is briefly described in technical characters in his list of the fungi of North Carolina. Roulin [12] in a memoir upon the physiological action of corn smut, presented to the French Academy in June, 1829, says that he had observed this malady of corn during a sojourn in South America. No other references to the disease in this country have come to light antedating 1850.

The very earliest record of corn smut appears to be by the French botanist Bonnet[13] in 1754, in his treatise on the function of leaves, who notes that "although it is classed with the smuts of other cereals, it produces effects altogether different, and unlike the others, it occurs on all parts of the plant." He mentions having received a letter from DuHamel in December, 1752, in which corn smut is spoken of; but he says that no reference to it was to be found in DuHamel's publications up to the time of his own book.

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[10] DeCandolle, Origin of cultivated plants: 390.

[11] Schweinitz, Synopsis fungorum Carolinae superioris, Schriften d. nat. Ges. 1: 71. 1822.

[12] Roulin, De l'ergot du mais, et de ses effets sur l'homme et les animaux. Acad. Sci. 1829. Quoted by Duchesne, Traite du mais: 64.

[13] Bonnet, Rech. sur l'usages des feuilles: 327-330.

The second writer to publish something relating to corn smut was Aymen[14], a corresponding member of the French Academy of Sciences, who described it briefly in 1760, as if no new thing. Again, in 1763, he[15] takes up the matter more fully, and details observations made by himself in 1752. In 1766 the influential writings of Tillet were published, founded on observations made in 1760 and 1761, already cited, followed after a time by the comprehensive and scholarly treatise by Imhof, also cited above.

These authors furnished the foundation for all subsequent writings upon the subject in France and in other countries, and also gave direction to some extent to the views of the uneducated. It will be seen that the earliest mention of corn smut in European literature is at least 150 years subsequent to the introduction of corn into Europe, and in American literature it is three-quarters of a century later. There is every reason to suppose that on both continents corn smut had existed, and even become common long before the time when it found mention in printed records.

THE LATIN NAME OF THE FUNGUS.

When searching the literature of the subject for information that would influence the course of our investigations, it was noticed that considerable diversity existed regarding the form of the Latin name for the fungus. In order to settle the question of the correct name, search was made through the early literature, especially in the libraries of the Universities of Bonn and Berlin, and more successfully in that of the British Museum. The conclusion and principal data have already been presented in an article in the *Botanical Gazette*[16] and only the more interesting points call for notice here. The object has been to find the earliest Latin name used in connection with a description identifying the fungus, which by rights, and in accordance with rules now generally followed by botanists, should be recognized as the correct name.

[14] Aymen, Recherches sur les progres et la cause de la nielle, Mem. de Math, et Phys. Acad. Sci. 3: 77. Paris, 1760. (Sometimes cited from the imprint at the bottom of the signatures: Sav. etrang.)

[15] Aymen, Second Memoire sur les maladies des bles, same, 4: 361. Paris, 1763.

[16] Arthur, The common Ustilago of maize. Bot. Gaz. 23:44-46. January, 1897.

Two prior attempts had been made to ferret out the true name. In 1881 George Winter [17] in reviseing the fungi of Rabenhorst's cryptogamic flora of Germany decided that DeCandolle had first published the name in 1806, which he construed as *Ustilago Zeae-Mays* (DC.) Wint. Again, in 1895, Magnus [18] of the University of Berlin, while studying the introduction of corn smut into central Germany, found an earlier name by De Candolle (1805), which gave the form *Ustilago Mays-Zeae* (DC.) Magn.

In our own search through the literature, a much earlier name than either of these has been found, and one to which no valid objection seems applicable. It was given by Beckmann [19] in a supplemental footnote to the translation of Tillet's paper before the French Academy, already abundantly cited, which he furnished to the *Hannoverian Magazine* for October, 1768. Beckmann was a distinguished professor of economics in the University of Gottingen, author of the "Principles of German Agriculture," which passed through a number of editions, of a cyclopedia of agriculture, and of numerous other papers and articles upon agricultural topics, as well as of a botanical dictionary. Subsequently a new genus was established for those smuts with which that of corn is still associated, and Beckmann's name was first used under this genus of *Ustilago*, by Unger [20] in his work on soils as influencing plant distribution. The name as it should now stand, is therefore *Ustilago Zeae* (Beckm.) Ung.

This name is not the one, unfortunately, which has been used heretofore by writers. The form has most often been *Ustilago Maydis*, which has usually been credited to Corda, but not infrequently to DeCandolle, Tulasne or Leveille, all botanists of note, who made important contributions to the subject of smuts. As a matter of incidental interest the following list of Latin names, applied at various times to corn smut, has been compiled, together with the citation of the works in which they were first published. The list may not be complete.

[17] Winter, Rabenhorst's Krypt.-Flora von Deutschland. 1:97. 1881.

[18] Magnus, Seit wann ist der Maisbrand in Mittel Deutschland? Deutsche bot. Monatsschr. 13:50. 1895.

[19] Beckmann, Hannoverisches Magazin. 6:1330. 1768.

[20] Unger, Einfluss des Bodens: 211. 1836.

USTILAGO ZEAE (Beckm.) Ung.

Synonyms:

1768 *Lycoperdon Zeae* Beckm, Hannov. Mag. 6:1330.
1805 *Uredo segetum Mays-Zeae* DC. Fl. France 2:596.
1808 *Uredo Zeae-Mays* DC. Eucyc. Meth. Bot. 8:227.
1815 *Ureao Maydis* DC. Fl. France 6:77.
1822 *Uredo Zeae* Schw. Schriften d. nat. Ges. 1:71.
1825 *Caeoma Zeae* Link Linne Sp. Plant, 2:2.
1833 *Erysibe Maydis* Wallr. Fl. Germ. :215.
1836 *Ustilago Zeae* Ung. Einfl. d. Bodens :211.
1842 *Ustilago Maydis* Cda. Icon. Fung. 5:3.
1847 *Ustilago Schweinitzii* Tul. Ann. Sci. Nat. III. 7:85.
1881 *Ustilago Zeae-Mays* Wint. Rabh. Krypt. Fl. 1:67.
1895 *Ustilago Mays-Zeae* Magn. Deutsch. Bot. Mon. 13:50

It is somewhat significant that the list is headed by Beckmann, a man whose interests were almost wholly on the practical side of the subject, and that he was closely following Tillet, who made his studies as a government expert working on the economic phase of the matter.

HISTORICAL PERIODS IN STUDY OF THE DISEASE.

In attacking the subject from the practical side, three periods in the history of investigation are to be recognized, dependent upon the dominant views regarding the nature of the disease and its mode of propagation.

The first period (1754-1832) extended from the earliest observations, those of Bonnet, Tillet, Aymen and Imhof, well toward the middle of the nineteenth century, or to be exact, to the publication of DeCandolle's important work on vegetable physiology. Although during all of this time systematic botanists classified corn smut as a fungus yet vegetable pathologists and practical observers treated the disease essentially as an edema. They believed that it was due to the excessive accumulation of sap in parts of the plant, causing lesions in which the sap and tissues degenerated into a black mass that finally dried into a powder. The conclusion was based upon inability to propagate the disease with the smut powder (spores), and the observation that it was most abundant upon plants in rich and damp soils, and was promoted by moist atmosphere and close planting. Bonnet. DuHamel and others thought that the swellings were incited by the sting of some minute insect, and a few writers believed them to be spontaneous abnormalities. The views of the period are briefly stated by Bonafous[21] in his memoir on maize.

[21]Bonafous, Histoire naturelle, agricole et economique du Mais : 94-99. Paris, 1836.

Translation of the part here referred to is given by Hitchcock and Norton, Bull. Kans. Exper. Sta., No. 62: 192-194. 1896.

For the agricultural practice, the closing words of Tillet's communication to the French Academy summarized the matter from the farmer's standpoint. He said that his studies showed that although they had good grounds for being afraid of wheat smut because of its contagiousness, yet they need not fear corn smut on that account, and if the disease is abundant one season, they need not in consequence be apprehensive of an increase of the disease the next season. Other writers during this period advocated cutting away the smut pustules. This was not to stop the spread of the disease, but to prevent the swellings from drawing the sap away from the ear and checking its development.

During the first period both belief and practice were erroneous, and were based on wrong deductions from imperfect knowledge.

The second period (1832-1895) extended from the time when DeCandolle's authoritative opinion [22] became dominant until the researches of Brefeld, a German botanist, still engaged upon studies of this nature, were published to the world[23]. During this period the disease was recognized as of parasitic origin, and due to the attack of the smut fungus. But the propagation of the disease was supposed to closely follow the fairly well understood course of the oat and wheat smuts. Brefeld said in his preliminary announcement to the Berlin Agricultural Club that "at the time of my first series of experiments in the year 1885, I still held to the old view, universally current, that smut germs generally could penetrate only into the young seedlings in order to appear later as smut masses in the full grown plant, and that consequently, a penetration of the germ into the plant when it had passed the seedling stage was not possible." It required an in-

[22] DeCandolle, Physiologie Vegetale 3: 453. Paris, 1832.

[23] The preliminary publication of Brefeld's work upon artificial infection of the corn plant with the smut parasite was presented to the Agricultural Club of Berlin in 1888, but it was not until 1895 that his extensive researches upon the question were completed and the record made available. The citations are as follows:

Brefeld, Oscar. Neue Untersuchungen uber die Brandpilze und Brandkrankheiten, Nachs a. d. Klub der Landwirthe zu Berlin, 1888 : 1577-1584, 1588-1593, 1598-1601.

Abstracts in Gard. Chronicle, 1888 : 396-397; Bot. Centralblatt, **39** : 15 18. 1889; and full translation by E. F. Smith in Jour. Mycology **6**: 1-8, 59-71, 153-164. 1890-91.

Brefeld, Die Brandkrankheiten des Getreides, Unters. a. d. Gesammtgeb. d. Myk. Heft 11: 52-92. pl. 2-5. Munster, 1895.

Abstracts in Bot. Centr. **64**: 273 281. 1895; **Hedwigia 34** : 138-140. 1895; **Amer. Nat. 30** : 137-142. 1896.

vestigator of the highest ability to break away from such firmly fixed beliefs, and to devise an entirely new course of experimental procedure, an honor belonging exclusively to Brefeld.

Very important advances were made in a knowledge of the fungus during this period. The able botanists who contributed most toward the development of this part of the subject (together with the dates of their most serviceable contributions) were doubtless Meyen (1838), Leveille (1839), Tulasne brothers (1847), DeBary (1853), Kuhn (1858 and 1874), Fischer von Waldheim (1869), whose memoir has been rendered into English, and Brefeld (1883). By the aid of improved microscopes, the course of the fungous mycelium inside the corn plant and the development of the spores were followed; the germination of the spores was accomplished in 1857 by Kuhn, who found that they germinated with difficulty, or not at all, in pure water, and later (1874) he observed the penetration of the germ tubes of the fungus as they pierced the epidermis of the corn plant. Brefeld in his first important memoir upon smuts made a highly valuable contribution to the subject, by showing that the corn smut spores would germinate with great readiness in nutrient solutions, and would even carry on an independent growth for a long time, forming great numbers of secondary spores, quite unlike those formed on the corn plant.

But all this information regarding the fungus led to no serviceable theory or practice in the prevention of the disease. Many were the vain attempts to prevent the smut by various applications to the seed. Kuhn, the most practical man among the many investigators, advocated the treatment of the seed with copper sulfate, and naturally was followed by other writers, until the method became current in standard works[24]; while all suggested the gathering of the smut in the fields and burning it, as a good general practice without knowledge of the specific reasons.

The third period opened with the brilliant researches of Brefeld, who completed our knowledge of the etiology and propagation of the disease by showing that the corn plant was open to infection at whatever point of its surface above ground the tissues were soft and still actively growing, that the disease was narrowly local in its action on the host, and that the infection was not by means of the black smut spores, but by colorless secondary spores produced aerially from a saprophytic growth of the black spores.

Brefeld's work essentially completed our knowledge of the

[24] Cf. Plumb, Indian corn culture:151. Chicago, 1895.

life history of the fungus and the course and propagation of the disease, only leaving for further study a verification of the main facts, extension of details, and devising of preventives.

THE SPORES AND THEIR GERMINATION.

The masses of corn smut, often as large as one's head, are mostly composed of a blackish powder, which is in reality, a wonderful collection of the minute spores of the fungus, countless and almost inconceivable in number. Under the microscope the powder looks like small, very small, balls, almost or quite round and covered over thickly with minute projecting points.

Each of these exceedingly minute globular grains of dust is capable of growth, if in sufficiently moist and fertile surroundings. It was formerly thought that the spores were only able to cause

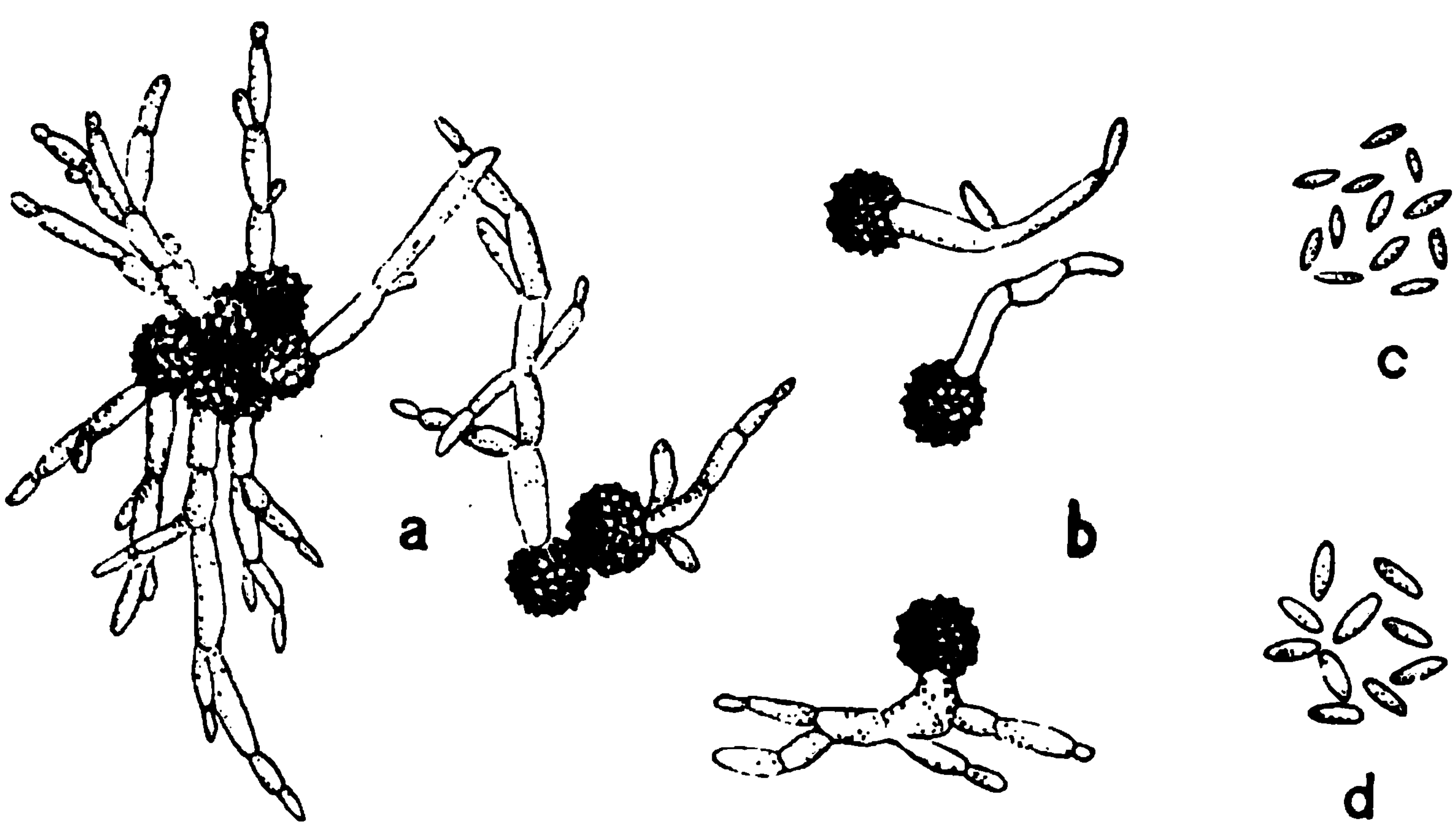


Fig. 1. Germinating spores of corn smut, and the resulting conidia: *a* two groups of smut spores showing mold-like growth after 36 hours; *b* three smut spores after having grown 18 hours; *c* conidia formed in the air, which are the chief means of infection of corn plants; *d* conidia formed in liquid, somewhat larger and plumper, but otherwise like the air conidia.

infection after they had passed a winter, and another warm season had begun. But this is an error. We have found that spores taken as early as the middle of July from corn plants in the field germinated within 24 hours after removing them from the pustule. They are in fact viable, and capable of starting infection from the time they are fully formed in the moist smut bunches until after a year or two, or possibly much longer, of the varying fortunes of refuse matter they cease to be alive.

The most significant observation, leading to recognition of the widely different physiological behavior of corn smut in contrast with the better known cereal smuts, was made by Brefeld, when he found that the spores which would not grow in pure water would make ample and characteristic development in nutrient fluids (Fig. 1, a, b). In such fluids, of which the liquor from barnyard manure was one of the best, the spores not only made a growth, but developed great numbers of thin-walled, colorless, secondary spores, of uniform size and shape, in every way unlike the black smut spores, and from their appearance evidently serviceable for greater multiplication of the disease, as was afterward proved by experiment. From their nature such spores are known to botanists as conidia (Fig. 1, d). Brefeld determined by experiment, and the observations have been repeated in our own work and also by others, that the black smut spores do not directly cause infection by growing into the corn plant, but after growing, as a mold grows, the conidia thus formed are able, when placed on the surface of young tender parts of the corn, to pierce the plant by means of a germinating tube, the infection leading to the production of smut masses at that place.

But the crowning discovery of Brefeld, which completed our knowledge of the essential features in the life history of the fungus and of the etiology of the disease, was announced in his memoir of 1895. He found that the growth from the black spores produced conidia in the air whenever possible, rather than beneath the liquid (Fig. 1, c). This now made Kuhn's observation of 1857 significant, that the spores germinate better in moist air than under water. In fact, it appears certain, without going into the details of experiments and studies which substantiate the deduction, that the corn smut disease is largely, possibly wholly, propagated by the conidia borne through the air from the growing black spores as they lie on the ground in barn yards, pastures and fields, and especially wherever decomposing vegetable matter provides extra nutriment.

In our own work spores were grown in such liquid media as beef bouillon, expressed corn juice, wort, Pasteur solution with and without sugar, and both hydrant and distilled water, and in such solid media as gelatin, agar-agar and starch paste. Of these the Pasteur sugar solution and agar-agar proved the most satisfactory. Excepting in clear water the spores usually germinate in eighteen to thirty-six hours. The growing spores and air conidia are shown in figure 1.

In studying germination and testing vitality in the Station laboratory, the spores were sown in a hanging drop, but in providing material for infection experiments upon growing corn plants the spores were sown in test tubes with both solid and liquid media.

STUDY OF AERIAL INFECTION.

The first successful infection experiment was conducted by Julius Kuhn of Halle in 1874; but as only a single seedling plant out of many trials showed disease, and as the methods employed as we now know, were not well adapted to corn smut infection, although suitable for some cereal smuts, it must be regarded in the nature of an accident. No other attempts at infection of the corn plant were successful until Brefeld began his fruitful studies (1885-87), with an entirely new hypothesis regarding the mode of propagation. Brefeld used for infecting material nutrient solutions containing a large quantity of conidia developed from the growth of smut spores, which he sprayed over the part of the plant where he hoped to produce the disease. The same method has been successfully employed by subsequent workers.

After many failures, due to a lack of appreciation for all the needed details of manipulation, successful experiments in infection were performed at the Indiana Station during the winter of 1897-98. For this purpose black smut spores were sown in test tubes of nutrient media, usually a Pasteur sugar solution, and when air conidia were abundantly developed the contents of the tube were thoroughly mixed and used as infecting material.

The plants for the first successful trial were started between folds of moist cotton cloth, the ordinary form of Geneva germinator being used. When the radicles had attained one to two inches and the leafy stem about one-half inch in length, they were subjected to the infecting material in form of a fine spray. After remaining in the moist cloths of the germinator 24 hours longer, they were transplanted to soil in pots and boxes, and placed in the green house.

Of nine corn seedlings infected at this time, December 4, 1897, six showed signs of the disease in 11 days. The tips of the young leaves were especially attacked, and the blades and stems to a less degree. Three of the six diseased plants lived to develop well defined smut pustules, which took about two weeks from the time of spraying, but all finally died from the debilitating effect of the disease. Four of the plants of this experiment are shown in plate XIII, the one diseased plant being stunted and

bent to one side by the pustules at its base, in marked contrast to the three healthy plants.

Another trial of the same kind was begun on February 11, 1898, by spraying as before four corn plants growing in small pots. The conidia were applied to the top of the plants just as the first leaves were unfolding. One of the four plants showed infection (see plate XIII), developed pustules at its base, and was distorted and weakened in the same manner as those of the previous experiment.

In this country successful attempts at artificial propagation of the corn smut disease have been carried out at the Kansas Station[26] in the open field, and at the Illinois Station, the latter not yet published.

The American studies show some of the conditions for effective propagation of the disease clearly enough, but we must turn to Germany, and particularly to the luminous work of Brefeld, to fully appreciate the behavior of corn smut in the open field. The facts appear to be that under ordinary conditions the conidia are the bearers of the disease. The conidia are minute, colorless and short lived sporidia, and are produced in the greatest profusion whenever the black smut spores find the necessary warmth, moisture and nutriment for their mold-like growth, which are provided at any time during the summer by damp, rich soil. As the conidia are borne through the air, which must be rather moist or they will be killed by drying, they come in contact with corn plants, and if there is the right amount of moisture present, each minute conidium sends out a slender tube that pierces the surface of the plant, provided it is young and tender enough at that point, and sets up the disease within. Any part of the corn plant above ground may in this way become affected with smut, but only during the time that it is still tender and growing. The leaves, stems, especially the nodes, brace roots, tassels and ears may thus become smutted, the ears being reached usually through the young silks. During the earlier part of the season the source of infection is the smut spores from the crop of the previous season, but later this source is supplemented by spores developed during the same season.

The great importance of destroying all smut masses, and doing this if possible before the spores have a chance to scatter out of the pustules, must be recognized in any plan for checking the disease.

[26] Hitchcock and Norton, Bull. Kans. Exper. Sta. No. 62: 183-187. 1896.

INFLUENCE OF WEATHER AND MATURITY ON INFECTION.

It is clear from what has already been stated that if infective material is available, that is, if viable smut spores are in the vicinity, the amount of infection will depend chiefly upon the character of the weather, and secondly upon the growing condition of the corn plants. As the plants develop, the parts that are successively formed are each for a time in a tender succulent condition during which they are liable to infection, but shortly pass over into sufficient maturity to effectively debar the entrance of the germ tubes.

Remembering that the disease is local, not spreading from organ to organ within the plant, but each infection causing pustules only at the spot on the plant where the germ tubes enter, it

TABLE XLIV.

Increase of smut pustules on different parts of the plant as the season progresses, as affected by drier and moister soil, season of 1896.

	DATES.	Leaves.	Stem 1st to 5th nodes.	Stem 5th node to tassel	Tassel.	Ear.
Drier soil.	July 6-7	35	2	1	0	0
	July 25-27	42	4	1	3	0
	Aug. 15-17	42	28	27	11	13
	Aug. 31	44	32	29	11	21
Moister soil	July 6-7	126	4	4	17	0
	July 25-27	144	49	6	48	0
	Aug. 15-17	151	89	37	76	23
	Aug. 31	152	96	42	78	26

could reasonably be expected that there would be an increase in the number of smut pustules as the season progresses. Actual count demonstrates this to be true.

For studying the progress of infection and of distribution of smut over the plant we may conveniently divide the plant into five regions: (1) lower portion of stem (between first and fifth nodes), (2) upper portion of stem (between fifth node and tassel), (3) leaves (both blade and sheath), (4) ears, infection being mostly through the silk, and (5) tassel, infection being almost wholly in the staminate flowers. Illustrations of smut pustules in these five regions are shown in plates X-XII, which are engraved from photographs.

Data on the first appearance of smut pustules are shown in

table XLIV, taken from a plat having the soil on one-half somewhat deeper and moister than on the other half, although the difference in surface level would scarcely be noticeable to the casual observer. In every other respect the two halves of the plat were alike. The table shows an increased number of pustules at each count, the largest portion being upon the leaves, and the next largest upon the lower half of the stem. That the ears are late in showing pustules, which moreover appear almost simultaneously, is accounted for by the fact demonstrated experimentally that their infection almost wholly takes place during the short interval while the silk is elongating and in vigorous growth. The table also shows that the more vigorous the growth of the corn plants, due to the moister, deeper soil, the greater the infection, a point which will be spoken of later.

If instead of counting the pustules the number of smutted plants be taken, the same progressive development of smut is evident. Table XLV is constructed from data taken from the

TABLE XLV.

Increase of smutted plants during season of 1896, as affected by slight differences of soil.

DATES OF OBSERVATION.	South half of plat; somewhat drier and shallower soil.			North half of plat; somewhat moister and deeper soil		
	Number of plants observed	Number of plants smutted.	Per cent of plants smutted.	Number of plants observed	Number of plants smutted.	Per cent of plants smutted.
July 6-7	1483	22	1.5	1536	80	5.2
July 25-27	1483	30	2.0	1536	149	9.7
August 15-17	1483	113	7.6	1536	251	16.3
August 31	1483	127	8.5	1536	266	17.3

same double plat that afforded data for the last table. The figures not only show that more plants became smutted as the season progressed, but that the largest increase of smut was about the middle of August, the infection for which must have been 10 or 15 days earlier. Observations made in Kansas[26] during June, July and August of 1894, 1895 and 1896, give similar and confirmatory testimony to the progress of smut during the season.

If the infection continues to take place throughout the season, it were highly probable that the longer the season of growth, the

[26] Hitchcock and Norton, l. c. page 179.

greater the amount of smut developed. Observations were made upon fields of early and late planted corn (table XLVI), and although other factors, such as the state of the weather at the different stages of maturity, may be accountable for part of the differences, yet the double amount of smut in the field planted seven weeks earlier was chiefly due to the longer period of growth affording a longer period for infection.

Another way in which the plant is made more liable to infection is by increase in the amount of tender growing tissue. This

TABLE XLVI.

Smutted corn plants in early and late planted fields, 1896.

	Planted about June 20.	Planted May 4.
Number plants counted	4647	2482
Number plants smutted	266	298
Percentage	5.7	12.0

may be brought about by more luxuriant growth, due to greater water or food supply. The accompanying table (XLVII) shows the effect of both moisture and richness of soil in promoting the smut disease.

In the first case the soil received same treatment for both halves of the plat, but as already explained, one-half had a greater depth before reaching subsoil and had a slightly lower surface and thus

TABLE XLVII.

Increase of smutted plants caused by greater moisture and by greater richness of soil, 1896.

	Dry soil Aug 31.	Moist soil Aug 31.	Unmanured soil Aug. 27.	Manured soil Aug. 27.
Plants counted	1483	1536	939	953
Plants smutted	127	266	59	120
Percentage	8,5	17,3	6.3	12.6

kept moister throughout the season. In the second case one-half of the plat was treated with fresh horse manure at the rate of six and three-fourths tons per acre. In both cases the more luxuriant growth of the corn plants gave the opportunity, through a greater exposure of tender tissues, for increased infection by the conidia

of the smut. In the two cases observed, moisture and food supply increased the smut 100 per cent.

These records show that the corn plant continues to be subject to infection by smut as long as it is growing, and that whatever increases growth increases proportionally the liability to infection.

The state of the atmosphere at the time the conidia are borne to the plant is most certainly an important factor in promoting the disease. It is only when the air is sufficiently damp that the conidia germs are able to keep their vitality, being very delicate and easily desiccated. Moisture on the surface of the plant is also required to induce germination and maintain growth until the fungus effects an entrance into the tissues. Yet rain interferes with infection, as it washes the conidia out of the air, and off from the plant.

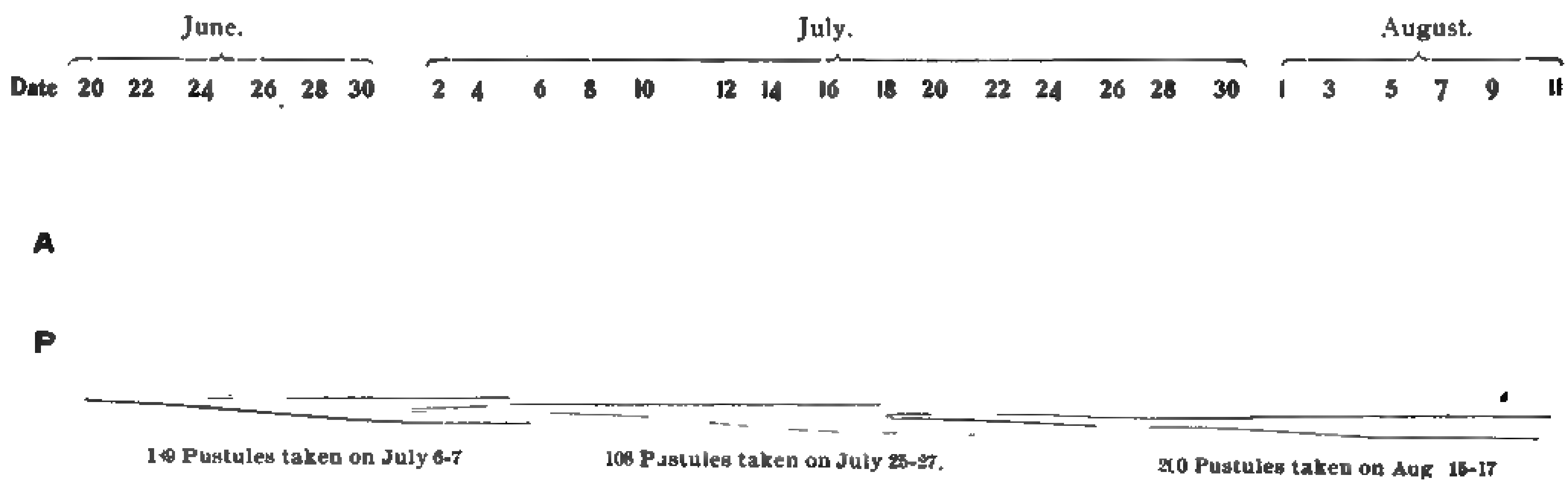
Many scattered facts and observations leave no doubt of the important part that atmospheric conditions exercise in a general way. It was early noticed that closely planted corn suffered more, which we now ascribe mainly to the increased dampness of the air immediately surrounding the plants in such fields. In conducting artificial infection one of the great obstacles to success is found to be the difficulty in maintaining a saturated atmosphere while infection is taking place.

Direct observation in the field upon this point is necessarily difficult, as the exact time of infection cannot be directly determined, but must be assumed to be some days before the pustules become visible. The period of incubation varies with temperature and other conditions affecting vegetation in general, but from experimental studies we may safely assume it to be from 10 to 20 days. Although without daily or very frequent observations on the appearance of pustules in the field, yet it will be interesting to see if the four observations taken in 1896 bear any relation to the weather conditions of the two or three weeks preceding.

The weather factors for the infectional part of the 1896 season are shown on chart XLVIII, and prominence is given to cloudiness and the degree of atmospheric moisture. The latter is represented by the difference between the readings of the wet bulb and dry bulb thermometers. The greater the difference, the greater the amount of evaporation and the necessarily drier air to produce it. In plotting the curve the dots are placed at a distance above the base line to correspond with the actual difference in the thermometer readings at each date. The curve has been drawn to rep-

CHART XLVIII.

Relation of smut infection to weather, as shown by atmospheric moisture. Cloudiness and precipitation for season of 1896



A. Atmospheric moisture. The dots show the average of morning and evening differential readings of the wet and dry bulb thermometers. The smoothed line approximates the general variation of moisture in the air, drier when the line rises and moister when it falls.

P. Precipitation: arrows indicate days when considerable rain fell, and dots when not enough to be measured in the rain guage. Heavy vertical shading indicates clouded sky throughout the day. Light horizontal shading indicates clouded sky part of the day

resent the average atmospheric moisture from day to day; rise in the curve indicates dryness of the air, and depression indicates moisture. Rainfall in itself can have only a deterrent effect, except in so far as it helps to saturate the air for the time immediately following, so the data for it are given an inferior place on the chart. But cloudiness, which is a highly important factor in keeping the atmosphere damp and in condition for the delicate conidia germs of the smut to float about and thrive, is shown by depth of shading. The temperature, which is high enough at all times throughout the period to insure germination and growth, would chiefly influence the rate of incubation of the smut, and is therefore omitted in the chart.

With this explanation the chart may be intelligently interpreted. It shows three clearly defined periods of moist, cloudy weather; one the latter part of June followed by a week of dry weather, one not so marked early in July followed by more than a week of almost uninterrupted dry weather, and an indefinitely long moist period beginning July 19. Each of these periods was followed by an outbreak of smut proportional to the degree in which the infectional period was favorable. The data were taken from the field supplying data for table XLIV, and include a count of over 3,000 plants. The June period of infection was followed by the appearance of 189 pustules; the early July period, which was not so favorable as the previous one, gave 108 pustules; and the late July period, which was more favorable than either, gave 200 pustules. Both weather and maturity of the corn plants were against any considerable infection during the fourth period, the count giving only 34 pustules.

Although the data here presented are imperfect, yet they clearly demonstrate that the state of the weather, especially the atmospheric moisture is an important factor in promoting the smut disease of corn. The capriciousness of the weather may reasonably be assumed to be the cause, in large part, why corn smut does not become a much greater pest than it now is.

DISTRIBUTION OF PUSTULES ON THE PLANT.

Records were secured in a number of fields in which the data were arranged for the five aerial regions of the plant; leaves, lower half of stem (including brace roots), upper half of stem, tassel, and ears, as stated in the previous section.

The observations made in 1895, in which areas representative of several fields of dent corn were selected and 1741 smutted plants found in a total count of 22,119, show that more than one

third of all the pustules occurred in the lower half of the stem. and that about an equal number of the remaining two-thirds was found on the upper half of stem, ears, leaves and tassels, respectively. The full data are exhibited in table XLIX. These proportions do not hold true in all cases, in fact no two fields and no two counts at different dates give the same relationships. The larger part of this variation can be ascribed to the disturbing in-

TABLE XLIX.

Distribution of smut pustules over the plant, data taken in several fields during the year 1895, 22119 plants being counted and 1741 of them found to be smutted.

REGION OF PLANT	Number of pustules.	Percentage of pustules.
Stem between 1st and 5th nodes	753	37.2
Stem between 5th node and tassel	342	16.9
Leaves (blade and sheath)	320	15.8
Ears	321	15.9
Tassel	287	14.2
Pustules on 1741 plants	2023	100.0

fluence of the weather, although the soil and other conditions of growth have somewhat to do with it, while a part is undoubtedly purely accidental.

The data taken in 1896 upon the plat having the soil of one-half moister than that of the other (table L) show that

TABLE L.

Distribution of smut pustules over the plant, as affected by moist and dry soil, observations made Aug. 31, 1896.

	REGION OF PLANT.	Number of pustules.	Percentage of pustules.
Drier and shallow soil.	Stem between 1st and 5th nodes	32	23.4
	Stem between 5th node and tassel	29	21.2
	Leaves (blade and sheath)	44	32.1
	Tassel	11	8.0
	Ears	21	15.3
	Pustules on 1483 corn plants	137	100.0
Moister and deeper soil.	Stem between 1st and 5th nodes	96	24.4
	Stem between 5th node and tassel	42	10.7
	Leaves (blade and sheath	152	38.6
	Tassel	78	19.7
	Ears	26	6.6
	Pustules on 1536 corn plants	394	100.0

most pustules appeared on the leaves, the lower half of the stem coming second, and that the increased growth due to the moisture is associated with an increase in the proportion of pustules on the leaves.

If we turn to data (table LI) taken upon the plat which had one-half enriched with stable manure, about the same relationships will be seen to hold as in the last case cited. Here the increase in the number of pustules due to more luxuriant growth is

TABLE LI.

Distribution of smut pustules over the plant as affected by richness of soil, observations made Aug. 27, 1896.

	REGION OF PLANT.	Number of pustules.	Percentage of pustules.
Unmanured.	Stem between 1st and 5th nodes	22	33.8
	Stem between 5th node and tassel	21	32.3
	Leaves (blade and sheath	8	12.3
	Tassel	10	15.4
	Ears	4	6.2
	Pustules on 939 corn plants	65	100.0
Manured.	Stem between 1st and 5th nodes	42	32.1
	Stem between 5th node and tassel	17	13.0
	Leaves (blade and sheath)	62	47.3
	Tassel	7	5.3
	Ears	3	2.3
	Pustules on 953 corn plants	131	100.0

especially marked in the leaves, while on the lower part of the stem the variation in percentage of pustules due to conditions of growth is slight.

Now turning to data taken from plats, or rather fields, for they were several acres each, which were planted at different dates, very different proportions will be seen (table LII).

The lower part of the stem is far ahead of the other regions, except in case of ears in the late planted field, a deviation which must surely be referred to the state of weather during the time infection was possible.

In general our observations appear to warrant us in assuming that at least in Indiana the lower half of the plant, especially if the leaves on that part be included, often bears more than half of the smut pustules, and sometimes far more than half, while

TABLE LII.

Distribution of smut pustules over the plant, as affected by date of planting; 1896. Observations made August, 1896.

	Region of Plant.	Number of pustules.	Percentage of pustules.
Planted about June 20. Obs. Sept. 19	Stem between 1st and 5th nodes	90	29.7
	Stem between 5th node and tassel	28	9.2
	Leaves (blade and sheath)	2	.7
	Tassel	2	.7
	Ears	181	59.7
	Pustules on 4647 corn plants	303	100.0
Planted May 4. Obs. Sept. 8.	Stem between 1st and 5th nodes	175	49.2
	Stem between 5th node and tassel	98	27.5
	Leaves (blade and sheath)	29	8.1
	Tassel	41	11.5
	Ears	13	3.7
	Pustules on 2482 corn plants	356	100.0

the upper part, including tassel and ear, is much less affected. It is partly to be accounted for by the longer period of exposure to infection, to the generally more favorable weather when in condition for infection, and to the prolonged opportunity for infecting the nodes enclosed by the leaf sheaths.

Corn, in common with other members of the grass family, keeps the lower end of the internodes in a tender growing state for a long period, and the requisite rigidity of the stem is maintained by the enwrapping sheath of the leaf. Moisture accumulates within the sheath and comes to hold more or less nutrient matter. It is a good culture solution for various germs, and smut spores finding their way between the sheath and the stem, may germinate, the conidia thus produced in turn germinating and piercing the plant where it is tender, just above the node. Plate X, A shows pustules at four lower nodes of a stem, each having become exposed by bursting the sheath. That these four spots received their infection from spores or conidia falling in between the stem and sheath, or washed in by rains, after the leaves were well expanded, appears to be highly probable.

The brace roots sometimes become affected through their tender ends, before these have penetrated the soil. Pustules thus situated have been counted in with those on the stem, in the above statistics.

The leaves are the part of the plant to first show pustules, as a rule, which mostly appear early, as may be seen by reference to table XLIV. This comes about from their habit of growth.

They expose more surface to infection than the other parts, and for a time they are the only part of the plant thus exposed, the stem being wholly enwrapped and hidden by them, and the ear and tassel appearing late.

In estimating the loss from corn smut, the investigator usually counts the stalks affected, and the farmer generally notices only the ears. The smut disease never kills the whole plant, unless it attacks a small seedling, and that is rare in the field, and it is even less likely to kill a part of the plant. The fungus derives its nourishment from the juices of the plant, and thrives as the plant thrives. To estimate the loss from smut, it is necessary to know how much the yield is decreased in weight and quality.

No wholly satisfactory statistics are available. That any plant supporting such a rampant fungus as corn smut must necessarily grow to a less extent than it would have done if none of its forces had been diverted, requires no argument. What we need to know is whether this stuntifying of the plant is uniform, or more in one part than another. The only data available are those taken in Kansas[27], where it was found that the loss of weight of ears on stalks smutted in all degrees was over 25 per cent., while the loss in weight of the rest of the plant was less than five per cent. In another set of weighings the loss in weight of ears on smutted stalks amounted to about one-third.

It may be safely assumed, we think, that the loss of crop is insignificant for the stover, being in fact almost wholly in the ears, and that there is considerable loss whether the ears themselves are affected or are sound but on smutted stalks. It would seem, that if the total number of smutted plants, however affected, be divided by three or four, a figure approximating the actual loss to the farmer would be secured.

PREVENTION BY SPRAYING.

In the light of what has been said above, the possible methods of preventing corn smut clearly resolve themselves into two categories. First the smut masses can be removed or destroyed before germination of the spores is possible, thus clearing the region of the infective material; or secondly, the growing plants can be protected by a fungicide or otherwise from the attack of flying conidia germs. This Station has done no experimental work along the first line and no record of such work with statistical results has come to the attention of the writers; but some

[27] Hitchcock and Norton, Bull. Kans Exper. Sta. No. 62: 171, 1896.

interesting and successful work has been done along the second line.

Experiments in spraying were carried out in 1895 and 1896 at this Station, with sufficient completeness to demonstrate the possibilities of this method of prevention. The only record of similiar work elsewhere appears to be that of a trial on a small scale at the Kansas Station by Kellerman[28] in 1890. Bordeaux mixture, chloride of iron and sulfide of potassium were used as the fungicides, and 86 plants were treated altogether, with 117 plants untreated for control. Eleven per cent. of smutted plants occurred in the untreated portion, against seven per cent. in the treated. The favorable result, however, was based upon too small a test to be especially significant.

In the experiments of 1895, some account of which has already been published,[29] one corner of a large field of dent corn, planted about May 8, was selected for the tests. Two fungicides were used, five rows being sprayed with Bordeaux mixture and five with ammoniacal copper carbonate, alternate strips of five rows each being left untreated as controls.

The spraying was done at frequent intervals during the time that infection was likely to occur, using a knapsack sprayer. Rain much interfered with the thoroughness of the work, as a shower soon after spraying washes away the fungicide and leaves the plants again unprotected. The state of the weather, therefore, largely controlled the time of spraying, and sometimes it became necessary to repeat the spraying after an inopportune rain. A number of rainy or wet days in succession gives the fungus an opportunity to secure a foothold that treatment by spraying can not reach.

The dates for rainfall and spraying, with the amount of rain covering the period during which infection was likely to occur, are given on the next page. On both June 8 and 19, after one plat had been treated with ammoniacal copper carbonate, it began to rain and the Bordeaux mixture was not applied to the other plat; on other dates the two plats were treated alike. The long interval without spraying between July 5 and 20 was an error due to absence, and gave an unfortunate opportunity for infection.

The Bordeaux mixture was made in the customary way, with

[28] Kellerman, Corn smut, Bull. Kans. Exper. Sta. No. 23: 103.
[29] Stuart, Fungicides for the prevention of corn smut. Proc. Ind. Acad. Sci. for 1895: 96-99.

six pounds of copper sulfate, four pounds of lime and 50 gallons of water. For a time this strength seemed to do no harm, but later the plants showed some injury, and after July 21 the solution was applied one-third weaker, that is 75 gallons of water were used instead of 50 in the recipe.

The ammoniacal copper carbonate at first was made by taking one ounce of copper carbonate and adding enough ammonia to

TABLE LIII.

Weather and treatment, 1895.

May 26 Rain .01 in.	July 14 Rain .13 in.
June 8 Sprayed	July 15 Rain .42 in.
June 12 Sprayed	July 17 Rain .63 in.
June 12 Rain .25 in.	July 18 Rain .22 in.
June 13 Sprayed	July 19 Rain .29 in.
June 17 Sprayed	July 20 Sprayed
June 18 Rain .02 in.	July 20 Rain .26 in.
June 19 Sprayed	July 21 Rain .03 in.
June 19 Rain .15 in.	July 25 Rain .25 in.
June 20 Rain .21 in.	July 25 Sprayed
June 21 Sprayed	July 27 Rain .23 in.
June 24 Rain .57 in.	Aug. 3 Sprayed
June 25 Rain .03 in.	Aug. 3 Rain .04 in.
June 26 Rain .13 in.	Aug. 6 Rain .35 in.
June 27 Sprayed	Aug. 11 Rain .11 in.
June 30 Rain .68 in.	Aug. 14 Sprayed
July 5 Sprayed	Aug. 26 Rain 1.02 in.
July 8 Rain .82 in.	

bring it into solution and then diluting with water to make nine gallons. This gave .088 per cent. of copper in the solution. The percentage of ammonia was not determined. As this solution proved injurious to the corn plants, it was soon replaced by one compounded in a different way. Instead of using any definite quantity of copper carbonate and then adding sufficient ammonia to dissolve it, the strong ammonia (28 per cent.) was reduced to 3.2 per cent, and an excess of copper carbonate added. This was shaken at intervals for some time to allow the ammonia to dissolve as much of the copper carbonate as possible. When wanted for use the clear liquid was taken and diluted to the strength desired. This solution, which now contained .148 per cent of copper and .14 per cent of ammonia, as determined by the method devised by Penny[30] of the Delaware Station, at first did no injury.

[30] Penny, Bull. Del. Exper. Sta. No. 22. 1893.

As it held nearly twice as much copper as the first solution, it is evident that it was not the copper, but the ammonia, that caused injury in the first trials. After a time the applications of this solution began to show evidences of injurious action, and after July 24 it was reduced in strength. From this time until the end of the experiment the solution contained .085 per cent of copper and .08 per cent of ammonia.

The first smut pustules were noticed on August 14 and the examination for percentage of smut was made on September 3, giving ample time for all infections to develop sufficiently to become evident. The results of the spraying are shown in table LIV, and give ample evidence of efficiency. The number of smutted stalks was reduced from 13 per cent to a little below seven per cent. by use of ammoniacal copper carbonate, and to a little below four per cent by use of Bordeaux mixture, that is to about one-half and one-fourth, respectively.

TABLE LIV.

Spraying corn plants with Bordeaux mixture and ammoniacal copper carbonate to prevent smut during 1895.

	Unsprayed	Sprayed with Bordeaux mixt.	Sprayed with am. copper carb.
Total number stalks	1441	365	347
Number stalks smutted	193	14	24
Per cent. smutted	13.4	3.8	6.9*

*This number is two-tenths larger than the one given in Proc. Ind. Acad. Sci. for 1895, page 98, an error in calculation having been discovered.

In 1896 further experiments in spraying were undertaken, using the same fungicides as in the previous year. The usual strengths were at first used, but as the season progressed had to be reduced, for as the plants became older they grew more susceptible to injury from the fungicide. The Bordeaux mixture at first (June 3) contained 50 gallons of water to six pounds of copper sulfate and four pounds of lime. On June 22, the water was increased to 60 gallons, and on July 10 to 75 gallons. The ammoniacal copper carbonate contained the following percentages of ammonia and of copper for the several sprayings:

	Ammonia.	Copper.
June 3	.15%	.159%
June 11 and 16	.10	.106
June 22 and 26	.08	.085
July 3, 10 and 17	.05	.053

The plants were sprayed for the first time on June 3, when they were from three to eight inches high and at intervals until July 17. Two days after this a severe wind storm, accompanied with heavy rain, blew down the corn so completely that further attempts at spraying had to be abandoned. More than a week of damp cloudy weather, with heavy rainfalls, immediately suc-

TABLE LV.

Spraying corn plants with Bordeaux mixture and ammoniacal copper carbonate to prevent smut, during 1896.

	Unsprayed	Sprayed with Bordeaux mixt nine times.	Sprayed with m. copper carb. eight times.
Total number stalks	1536	704	733
Number stalks smutted	266	61	65
Per cent. smutted	17.3	8.6	8.8

ceeded the windstorm, and provided conditions for infection that doubtless sufficiently account for the rather large percentage of smut among the sprayed plants. The first pustules were seen July 6, and on August 31, the final record of smut was taken.

The result of this year's work, in spite of the early date at which the sprayings ceased, was highly encouraging. In table

TABLE LVI.

Frequency of spraying in its effect upon corn smut in 1896.

	Un-spray-ed.	Sprayed with Bordeaux mixture		Sprayed with am. copper carb.	
		June 26. July 10.	Jun. 3 11,22 July 10.	June 26 July 10	June 3,11,22 July 10.
Total number stalks	1503	350	338	394	387
Number stalks smutted	127	25	11	29	30*
Per cent. smut	8.5	7.1	3.3	7.4	7.8*

*These numbers are so large that they must clearly be due to some accident, probably imperfect spraying.

LV the amount of smut is shown to have been decreased 50 per cent. by use of Bordeaux mixture, and slightly less by the ammoniacal copper carbonate, the former having been applied

A B

SMUTTED CORN TASSELS.

A shows many pustules of smut developed on the staminate flowers.

B shows an accumulation of smut pustules on parts of the upper leaves where moisture was held for a time just previous to appearance of the tassel. The growth of the tassel was checked by the smut.

A B

EARS OF SMUTTED CORN

A illustrates the action of smut when only part of the silks are infected by smut conidia; half of the ear is consequently well developed, the other half is smutted.

B shows an ear with every kernel smutted. The conical shape is due to the earlier smutted part at the base of the ear absorbing the nutriment derived from the stalks to so large an extent as to partially starve the smut toward the apex of the ear.

RESULTS OF ARTIFICIAL INFECTION.

The upper figure shows a corn seedling bent to one side by a pustule of smut at a lower node, just above the soil. The right hand plant remained unaffected.

The lower figure shows three unaffected corn plants, and one bent to one side by a smut pustule. The plants were all of the same age, and the exhaustive effects due to the growth of the smut are well shown.

VIEW OF PIGGERY.

nine times between June 3 and July 17, and the latter eight times, the dates (given on a previous page) being the same for both with the exception that spraying with ammoniacal copper carbonate was omitted on June 8. In table LVI the results of spraying one-half and one-fourth the number of times during the season are given, and show a general falling off in efficiency as the sprayings are decreased.

The data in tables LV and LVI, although not exactly comparable, being taken from different, yet near by fields, still clearly show that Bordeaux mixture when applied at the right time, even with so few as four applications, will greatly reduce the smut, and furthermore that ammoniacal copper carbonate is by no means so important a fungicide for the same purpose.

By considering the percentage of reduction effected in the three trials at this Station, as in table LVII, it may be seen that in our experiments the use of Bordeaux mixture brought

TABLE LVII.

Percentage of reduction of smut in corn brought about by a different number of sprayings during the seasons of 1895 and 1896.

	Sprayed with Bordeaux mixture.	Sprayed with am. copper carb.
Sprayed 10 times 1895	72	49
Sprayed 8 times. 1896	50	49
Sprayed 4 times, 1896	61	8
Sprayed 2 times. 1896	16	13

about a reduction of smut amounting from 72 to 16 per cent., according to the number of sprayings, and that ammoniacal copper carbonate gave from 49 to eight per cent. That spraying is a genuine means of controlling corn smut, and that for the purpose Bordeaux mixture is preferable to ammoniacal copper carbonate we believe may be regarded as beyond question.

It must be pointed out in this conection that while judicious spraying is capable of largely reducing the amount of smut in a crop, it cannot wholly prevent it. This is partly on account of the not infrequent interference of protracted bad weather, and more particularly on account of the impossibility of protecting the ear, by any method of spraying. The ear is infected through the young silks, and these cannot be effectively sprayed, or if they could be, it would also prevent the pollen from acting and thus induce sterility. While spraying, however, cannot be expected to prevent loss from smut in the ear, yet it is capable of greatly re-

ducing the loss in weight of ears that are not themselves smutted, but are on stalks which would otherwise bear smut. What this amount of saving is can only be conjectured in the absence of statistics.

When the expense of spraying and its limitations are considered it is doubtful, however, if it can be regarded as a practicable or promising method for the control of smut in field corn. So obvious is this, that we think it superfluous to present figures on the expense of spraying and the profit from it. Although we have demonstrated that spraying can be made effective for the saving of half or more of the usual loss from smut in corn, yet we expect no farmer to adopt the practice. The work clearly shows, however, that the assumption that corn smut infection is conveyed though the air must be correct, for when the surfaces of the plants are protected by a fungicide, the smut infection is reduced or prevented. It is, therefore, worth while to inquire if the source of the infection cannot be reached and removed.

PREVENTION BY DESTROYING SMUT MASSES.

In the prevention of corn smut, having shown the worthlessness of all treatment of seed and the moderate value only of treatment by spraying, some words should be said regarding the only method that at the present time really appears to promise a practical way of controlling the disease, that is gathering and destroying the smut masses. As already mentioned, no statistics have been taken on either the cost or effectiveness of this method, but there is every reason to believe that in both respects it is practical and profitable.

During the early part of the century European writers advocated cutting away the smut pustules as they appeared on the plants, in order to stop the fungus from weakening the corn plant. Later, when it was fully understood that the disease was propagated through the medium of the smut powder, writers advised the collection of the smut masses, on the ground that it is well to destroy pestiferous growths of all kinds, and in so doing lessen the chances for their increase.

Not until recently have the reasons for this form of procedure been capable of satisfactory statement. We now know that the spores at any time for a year or more after they turn black in the pustules, whether attached to the living or dead corn plant, or blown about over the fields and meadows, are capable of growth, moisture and temperature favoring, and of the production of minute conidia by the hundred fold, which carried by the air dissem-

inate the disease to the growing corn plant, throughout the warm season of the year. The corn plant is subject to infection as long as it has tender growing tissues, practically until it is nearly matured in late summer.

What is needed from our present point of view is to gather the pustules as they appear in the field, and destroy them, and it is believed that the amount of smut subsequently appearing in the vicinity will be largely decreased, the decrease being greater the longer the practice is maintained.

The plan should be to go through the field more than once while the corn is still growing, beginning in July, and finally while husking or handling the fodder to secure smut masses previously overlooked. These should be burned or put in boiling water, to destroy the life of the spores. Care should be taken not to permit the black powder to be scattered in the handling.

This is a simple and feasible thing to do. What it will cost we do not know, but believe that Professor Bessey, formerly of the Iowa Station, now of the Nebraska Station, was liberal in his estimate when he said some years ago that "the cost per annum of gathering and burning the smutted ears ought not to exceed 10 or 15 cents per acre; a smart boy carrying a bag slung over his shoulder ought to be able to earn good wages in 'smutting' corn at 10 cents per acre."

The matter of cost is a practical one, and by rights its estimation belongs to the man whose interests are at stake. This Station has incurred considerable expense and been to much pains to secure the facts set forth in this report. If the farmers of the state will report to the Station any work they may undertake in this line of prevention, the information will be heartily welcome, and will be accepted as an appreciative response to efforts in their behalf. We would be glad to know how much smut was gathered, the dates, time occupied, cost, and any other kindred items thought to be of interest.

INJURY TO ANIMALS.

The conspicuous and peculiar development of corn smut has at all times excited deep suspicion that it would prove harmful to the animal economy, especially if eaten. One of the first close investigators of the parasite, Imhof, felt it necessary when he wrote in 1784, to show whether this assumption was well founded or not. He experimented upon himself by taking a considerable quantity of the spores before breakfast every morning for a fort-

night, also applying the spores to a wound on his hand, and employing them as snuff. He experienced not the slightest harm or ill effects from their use. In 1836 Bonafous records his observations at some length. He fed cats, geese and chickens for several days with smut powder mixed with food in equal quantities, and they ate it readily with no appearance of injury. He also took some himself at different times, and had observed that cattle ate it freely, entirely without bad results.

Reports in the agricultural journals[31] are sufficiently numerous to indicate that the opinion is wide spread and general, even at the present time, that corn smut is a dangerous food material. In the early days its reputation was even worse, in fact astonishingly bad, if we may trust the word of Roulin, who read a paper before the French Academy in 1829 on the "Ergot of maize, and its effect upon men and animals." He asserts that in Colombia. S. A., where he traveled, the smut caused the hair of men, mules and pigs to fall out, and sometimes the limbs were atrophied and weakened; wild animals, such as deer, native dogs, monkeys and parrots, would eat so heavily of it as to be prostrated before they could leave the field. Yet he says that when this same smutted corn was carried into the mountainous uplands, it no longer proved harmful, and could be eaten without deleterious effects. His description reminds one of the symptoms

[31] A few citations are given here, although many others might have been produced.

1861. Amer. Farmer. E. Wood reports having lost 3 oxen, 3 cows and 3 calves from eating corn smut.

1865. Country Gentleman (p. 43). D. M. M. attributes loss of hair in cattle to corn smut.

1869. Country Gentlman (p. 275). R. J. L. reports the death from smut of several cattle in his vicinity.

1876. Country Gentleman (p. 795). O. S. Randall of Iowa reports the loss by one of his neighbors of 8 head of cattle and by another of 2 head from eating smut.

1878. Country Gentleman (p. 584). S. P. of Vermont states that he has lost several head of cattle and sheep on account of smut.

1880. Amer. Agriculturist (p. 447). The editor considers it injurious to stock.

1881. Amer. Agriculturist (p. 318). A writer deems it injurious and capable of causing abortion.

1881. Country Gentleman (p. 579). H. Stewart of New York believes it causes abortion.

1898. Farmer's Guide (p. 642). The editor speaks of the general belief that it causes abortion and other ills.

now ascribed to the so called corn stalk disease of the middle west, a malady or group of maladies, not infrequently charged to corn smut.

Recent tests in feeding smut, as well as other experimental evidence, agree with the earliest trials, however, in maintaining its essentially innocuous character in spite of popular opinion to the contrary. Practically no work of this character has been done by this Station, and only the briefest outline of work elsewhere can be given room.

In 1869 Gamgee[32], while employed by the U. S. Department of Agriculture, fed two cows with 42 pounds of corn smut. Each cow was given, beginning on February 26, one and a half pounds of corn meal, mixed with three ounces of smut thrice daily, and cut hay without restriction. For one cow it was given dry and for the other wet. The amount of smut was subsequently increased to six ounces, and after a time to 12 ounces. At the end of three weeks one cow had gained a little in weight, and the other which received dry food, lost a little. No symptoms of injury were noted.

In the fall of 1880 Henry[33], of the Wisconsin Station, fed two cows with smut. One cow was given six ounces, mixed with bran, in two daily feeds, which was gradually increased to 32 ounces by the eleventh day. No evil effects resulted. The other cow was fed in the same way, the increase being to 64 ounces, by the thirteenth day, when the trial was interrupted by the sudden illness and death of the animal. A post mortem examination not embracing the brain, however, gave no evidence that the smut caused the sickness.

In 1889-90 a trial was made by Professor Morrow of the Illinois Station, reported by Moore[34], of feeding a steer one pound of smut daily for 20 days and then about one and a half pounds for 22 days more, with no symptoms of injury.

In 1893 and 1894 experiments were conducted by Dr. F. L. Kilborne, under government auspices, and reported by Moore, in which a large amount of smut was fed to three two year old steers for seven days in the first trial and to two heifers for 16½

[32] Gamgee, Report of Commissioner on Diseases of Cattle in the United States: 73-81. 1871.

[33] Henry, Rep. of Regents Univ. Wis. 1881: 50-54. Abstract in Tenth Rep. Wis Exper. Sta. for 1893: 81-83, and in Breeder's Gazette 14: 360. 1888.

[34] Bull. Bureau Animal Industry. No. 10: 15-16. 1896.

days in the second. One heifer consumed an average of over three and a-half pounds of smut daily and the other over four pounds. None of these animals showed any ill effects.

In the fall of 1895, Clinton D. Smith[35] of the Michigan Station, tried feeding smut to four cows, three of them pregnant. Two of them were given smut daily for 11 days, beginning with two ounces and increasing regularly to one pound each, this last amount filling a two-quart measure. The other two cows were fed 43 days, and received an amount beginning with two ounces and increasing to 11 pounds daily for each. Ten pounds would fill a half bushel measure. It proved an acceptable food, being preferred when in moderate amount, but palling somewhat when excessive, all the animals thriving on it, without symptoms of injury in any particular.

At about this time Mayo[36] of the Kansas Station administered to Guinea pigs a concentrated alcoholic extract of corn smut, which proved entirely harmless.

The only direct test coming to our attention in which deleterious results could be ascribed to the smut is recorded in a German veterinary magazine. In 1860 the abortion of 11 cows, said to have eaten corn smut, was observed by Haselbach[37]. Wishing to learn the truth of the assumption, he fed two bitches with 15 grams (about one-half ounce) of dry smut each, and on the day following half that amount, with but little other food. Abortion followed. The information is too meager, however, to give this instance much weight.

More or less complete chemical analyses have been made of corn smut. The analysts[38] have found substances in which they trace a resemblance to ergot and thus appear to confirm the popular opinion that it contains some active principle; Cressler separated what he thought to be an alkaloid identical with that of ergot, and Rademaker and Fischer called a similar substance

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[35] Smith, Bull. Mich. Exper. Sta. No. 137: 41-46. 1896.

[36] Mayo, Bull. Kans. Exper. Sta. No. 58: 68-70. 1896.

[37] Haselbach, Magazin fur Tierheilkunde, 1860. Quoted in Zurn and Plant, "Die Pflanzliche Parasiten auf und in dem Koerper unserer Haussaugetiere." 2nd ed. Weimer, 1887. Page 68, footnote.

[38] Dulong, Jour. de Pharm. 14: 556. 1828.

Cressler, Amer. Jour. Pharm. for 1861: 306.

Parsons, Rep. Dept. Agric. for 1880: 136-138. 1881.

Hahn, Amer. Jour. Pharm. 53: 496. 1881.

Rademaker and Fischer, Med. Herald for 1887: 775.

found by them *ustilagin*. Other chemists[39] applying the customary tests to extract solution, find no evidence of an alkaloid in corn smut, and believe the substances so referred by the analysis to have been decomposition products not present originally in the smut. From the results of some preliminary tests made by ourselves, we are inclined to dissent from the views of of the two last mentioned investigators. The results obtained by reputable physicians in the use of the fluid extract as an oxytocic medicine indicates that it possesses some principle comparable with the active agent in ergot, although that agent may not necessarily be an alkaloid, according to recent studies.

The physiological action of corn smut, used as a fluid extract, has been studied by Mitchell[40] of the Medical School of the University of Pennsylvania in 1883, by Taylor of the Jefferson Medical College in Philadelphia in 1886, and by Burt, probably in 1868. We have, unfortunately only been able to consult the first one of these theses. Dr. Mitchell experimented upon frogs, and found that its action upon the nervous system was marked. It especially affected the cerebral portion of the brain and the receptive part of the spinal cord, causing a loss of reflex movement, depression and irregularity in respiration, with some convulsions. If the amount of the drug administered was large, volitional movement was suspended as well as the reflex movement, inducing paralysis. Although the narcotic action proceeds from the nervous centers, yet death is directly caused by arrest of respiration. If death does not ensue, the animal soon recovers and shows no harmful results from the experience. He considered the action of the drug to be similar to that of potassium bromide, and somewhat less so to that of ergot.

The question that chiefly interests the farmer in this connection is whether corn smut when mixed with food is a poison or not. If for clearness, we agree that, to quote a medical authority, "poison is a drug, whether animal, vegetable or mineral, which in small quantities destroys health and life, but differs from a medicine only in the degree or intensity of its effects," I think we must conclude that corn smut is not a poison. The overwhelming evidence that cattle and other animals may eat it in large quantities and show no abnormal effect clearly proves that point. On

39 Kedzie, Bull. Mich. Exper. Sta. No. 137: 45. 1896.
Mayo, Bull. Kans. Exper. Sta. No. 58: 69. 1896.

40 Mitchell, Jas. The physiological action of Ustilago maidis on the nervous system. Inaug. Thesis, Univ. Pa. 1883. Therap. Gaz. Detroit 10:223-227. 1886.

the other hand, certain excessive amounts are capable of producing convulsions, paralysis and death. There can be no doubt that the death of one cow in the trial conducted by Henry, in Wisconsin, was due exclusively to smut poisoning, the symptoms being concordant with those produced in laboratory studies. Professor Henry's conclusion [41] – "it is most evident to my mind that the cow was killed by the corn smut, and that the brain was affected thereby"—is shown to have been well taken, and now stands beyond question.

Of course some rational explanation is required to account for the rarity of symptomatic results when smut is fed to animals, even in large amount, for I think we must agree that half a bushel a day, as in the Michigan trials, is a large amount. In the first place animals probably differ much individually in their susceptibility to such narcotic poisoning. Then it has been noticed that smut fed dry more often produces abnormal effects than when fed wet, which has led writers to conclude that all the action followed purely from physical causes[42]. But this view appears to be no longer tenable, for injury to the digestive tract has not been observed by any veterinarian or experimenter, even in small degree. It is possible, however, that when the smut is taken dry the narcotic principle is more surely and quickly extracted from the fungus while in the animal's stomach, and also more readily absorbed into the system and rendered effective. This leads, naturally, to the question of the digestibility of the fungus, and its properties as a food, for the medicinal agent may be so effectually guarded by the indurated coat of the spores that it ordinarily does not escape, or only in small amount, during the passage through the animal. On this topic little information is available, but what there is will be given later.

We may sum up the results of our inquiry into the medicinal or poisonous action of corn smut as follows: as eaten by animals in the field it is only rarely injurious; the action, when any occurs, affects the nervous system, and except in the unusual case of death, causes no permanent injury; the alkaloidal, or other active principle, occurs in corn smut in small amount, and only under rare and exceptional circumstances is an animal likely to eat enough of the smut in any form to be affected by it. Besides being capable of causing convulsions and paralysis when admin-

[41] Henry, W. A.—Breeders' Gazette 14:360. October, 1888.

[42] Chestnut, Preliminary catalogue of plants poisonous to stock. Annual Report Bureau Animal Industry for 1898:393.

istered as a drug it will also stimulate uterine contraction, but its action is so mild that abortion is but a remote possibility.

In short, corn smut is but rarely injurious to animals, and then only when eaten in excessive amounts, and often not even then. What small danger there is somewhat increases when cattle are restricted in amount of water and in other palatable food, as occasionally occurs when they are turned into a field of smutted corn stalks during a period of drouth. Smut is relished by most cattle, and they are likely to eat all that can be found.

DIGESTIBILITY OF SMUT.

It is a constantly repeated assertion, when the question of the spread of the smut disease by stable manure is touched upon, that the spores are not acted upon by the digestive processes, and that they pass through the animal with their germinating powers unimpaired. This appears to rest upon no direct evidence, if we may except one obscure instance not generally known to American writers. The observation referred to was reported in an Italian veterinary journal[43] for 1884. Spores that had passed through the alimentary tract were found to be in viable condition and in part germinating.

A test made by ourselves does not substantiate this report. Material was collected the day following the feeding of smut, a cow having eaten about a half bushel of corn smut freshly gathered from the field (in December), given with her three daily rations. The moist material was permitted to remain unseparated for 24 hours at ordinary room temperature, which is high enough to induce germination of corn smut spores under right conditions of moisture. The spores were then washed out and tested in drop cultures, using Pasteur sugar solution, manure liquid, and pure (distilled) water. Control cultures were made in the same media, spores being taken out of the material from which the cow had been fed. Good germination resulted in all the control cultures, but not a spore grew in the others, although the tests were repeated, nor were there any indications that germination had in any case taken place during the previous 24 hours while the material had been kept under favorable conditions. The microscopic appearance of the fresh and ingested spores was not materially different, but the latter were undoubtedly unviable. This is but one test, yet the conditions were favorable, the animal having been fed an excessive amount of smut (and without noticeable injury), and the control showing good power of germination.

[43] Morini, Clin. Veterin. 1884. Abs. in Bot. Centr. 21:367. 1885.

We may grant the correctness of both these observations by assuming that in cases where the animal is fed to excess, and is somewhat cloyed, part of the spores may occasionally pass uninjured, as sometimes happens with corn, oats and other seeds. Nevertheless, there seems to be very little warrant for the customary statement that the smut disease can be spread by the smut fed to animals. True, the uneaten portions may be carried back to corn land with the unfermented parts of the manure, and thus prove to be infective, but that is a different matter, already discussed.

This view of the digestibility of the spores, that is, that while the exterior, dark colored wall of the spore, from its indurated and highly resistant character, is little affected by the digestive processes, yet the contents of the spore are more or less extracted, is a view that accords well with the fact brought out by a number of experimenters, that animals thrive upon a ration having smut as the principal ingredient. Analysis, in fact, shows that corn smut is possessed of high nutritive value[44] containing more protein than does corn, oats or clover hay, together with a high content of carbohydrates. All this nutritive material is not inside the spores, however, for our own tests with Fehling's solution show that much of the sugar present is associated with the general detritus which accompanies the spores. This sugar, which is probably derived from the corn plant during growth, rather than from the fungus, was found by Dr. Kedzie to amount to four per cent. of the dried mass, and he considers that it accounts for the relish with which cattle eat the smut.

It is doubtful if any one will ever find reasons for advocating the use of corn smut as a food for cattle, yet when judiciously fed, it is probable that animals will thrive as well on it as on other rich foods, and that the danger from narcotic poisoning is so exceedingly small that it may well be disregarded.

The need of further research upon the digestibility of smut, the spores and detritus being separately considered, is, however, emphasized by the anomaly that while smut does contain a certain small amount of an active principle, and that the soluble parts of the smut appear to be digested and absorbed by the animal system, yet of the many animals that the records show have been experimentally fed with large amounts of smut only one has been fatally injured, and few others or none have shown abnormal

[44] See Bull. Mich. Exper. Sta. No. 137:45. 1896; and Farmers' Bulletin No. 69:17. 1898.

symptoms. It may be that most cattle are little susceptible to this kind of narcotism, or they do not absorb the deleterious substance readily, or it is present in exceedingly small amount. At any rate, an explanation of some of the discrepancies between various reports must await investigation of the facts.

SUMMARY.

The results of our investigations and studies may be summarized as follows:—

1. The common smut of corn, the true Latin name of which is *Ustilago Zeae*, has been known, according to published accounts since 1822 in America, and since 1752 in Europe.

2. From the first, smut has been considered by cultivators and scientists alike as the cause of much injury to the corn crop. The loss will average one to three per cent. a year for Indiana, and sometimes far exceeds this amount. Reckoned as money, the loss averages 10 to 30 cents an acre, or $375,000 to $1,125,000 a year for the whole State, with some years much higher.

3. Experimental studies under direction of the French government were begun over a hundred years ago. But a knowledge of the life history of the fungus, which was necessary before a rational means of controlling the disease could be devised, was only completed in 1895, by the admirable researches of Brefeld in Germany.

4. During the first period of the study of smut as a disease of corn, from 1754 to 1832, the erroneous opinion prevailed that it was due to an excessive accumulation of sap in parts of the plant, thus causing tumors. During the second period of study, from 1832 to 1895, the smut fungus was recognized as the cause of the disease, but it was erroneously supposed that the spores infected the corn plant through the seedling by being planted with the seed. During the third period, from 1895 to the present time, it has been recognized that smut spores of corn, unlike those of some other cereals, grow at any time during the warm season, produce much smaller, secondary spores (conidia), which carried by the air infect the corn plant at any part of its surface that is in a sufficiently tender and growing condition, and that the disease is localized in the immediate vicinity of the infection.

5. The spores germinate upon the ground, or wherever warmth, moisture and soluble food material are available. They grow slowly, or not at all, in pure water, but develop luxuriantly in drainings from manure and other solutions containing plant food. They grow as mold or as yeast grows, and form numerous

BIBLIOGRAPHY.

The following works have been consulted in the preparation of this paper. In addition to the works which have been seen and read by the writers, some were available only through abstracts; these are indicated by a (||), and a few only known to us by title, which are marked with an asterisk (*). Numbers in broad face type stand for volumes, those following colons for pages. When page numbers are joined by a hyphen, the matter extends from one to the other, when separated by a column the matter occurs only on the pages named.

Arthur, J. C.—Report of the botanist, Rep. Ind. Exper. Sta. for 1891: 23-24. 1892.

Arthur, J. C.—Treatment of corn smut, Newspaper Bull. Ind. Exper. Sta. no. 16. Nov., 1895.

Arthur, J. C.—Report of the botanical department, Rep. Ind. Exper. Sta. for 1895: 24-26. 1896.

Arthur, J. C.—The common Ustilago of maize, Bot. Gaz. **23**: 44-46. 1897.

Arthur, J. C.—Formalin for grain and potatoes, Bull. Ind. Exper. Sta. no. 77: 38-44. March, 1899.

Aymen,—Recherches sur les progres et la cause de la nielle, Mem. Acad. Sci. Paris, **3**: 68-85. 1760.

Aymen,—Second memoire sur les maladies des bles, Mem. Acad. Sci. Paris, **4**: 358-398. 1763.

Beal, W. J.—Indian corn, Rep. Mich. Board Agric. for 1880: 288. 1880.

||Beck, G.—Versl. Medel. K. Akad. Wet. Amsterdam **3**: 115-122. 1885. Abs. in Jour. Roy. Micr. Soc. for 1886: 489.

Beckmann, J.—Des Herrn Tillet Beobachtung einer Krankheit des turkischen Weitzens oder des Mais, Hannoverisches Magazin **6**: 1329-1340. 1768.

Beckmann, J.—Grundsatze d. teutsch. Landw. 4th ed.:146. Gottingen, 1790. Same, 6th ed.:190. 1806.

*Beckmann, J.—Biblioth. Physic. Oeconom. **7**: 135.

Berkeley, M. J.—Gard. Chron. for 1850: 675.

Bessey, C. E.—The smut of Indian corn, Bull. Iowa Agric. College for Nov., 1884: 127-129.

Bessey, C. E.—The smut of Indian corn, Bull. Neb. Exper. Sta. no. 11: 25-35. 1889. Reprinted in Bull. Ohio Exper. Sta. no. 10: 264-272. 1890.

Blair, E. S.—Ustilago maidis, Therap. Gaz. Detroit **17** : 291-292. 1893.

Bonafous, M.—Histoire naturelle, agricole et economique du Mais: 94-99. Paris, 1836. Partial English trans. in Bull. Kans. Exper. Sta. no. 62: 192-194. 1896.

Bonnet, Ch.—Recherches sur l'usage des feuilles: 327-330. Gottingue. 1754.

*Bosc, J. A.—Dict, rais. d. Agric. **4**: 65-66. Abs. in Ann. Sci. Nat. ser. 3, **7**: 24. 1847.

Brefeld, O.—Die Brandpilze, Bot. Unters. Heft. 5: 67-75. Leipzig, 1883, Abs. in Oesterr. bot. Ztschr. for 1883: 267; Jour. Roy. Micr. Soc. **2**: 877. 1883; Gard. Chron. for 1889: 267-268; Amer. Nat. **30**: 224-226. 1896.

Brefeld, O.— Neue Untersuchungen uber die Brandpilze und die Brandkrankheiten II, Nachr. aus d. Klub d. Landw. Berlin 1888: 1577-1584, 1588-1593, 1598-1601. English trans. by E. F. Smith in Jour. Myc. 6: 1-8, 59-71, 153-164. 1890-91. Abs. in Gard. Chron. for 1888:396-397 and for 1889:267-268; Bot. Centr. 39:15-18. 1899; Just's Bot. Jahresb. for 1888, 16:318. 1890; Bot. Centr. Beihefte 50: 63. 1892.

Brefeld, O.—Infectionen mit Maisbrandconidien, Unters aus d. Gesammtg. d. Myk. Heft 11:52-92. Munster, 1895. Abs. in Bot. Centr. 64: 273-281. 1895; Hedw. 34: 138-140. 1895. Amer. Nat. 30: 137-142. 1896.

Buckhout, Wm. A.—Rep. Penn. Exper. Sta. for 1891: 179-180. 1892. Abs. in Exper. Sta. Rec. 5: 61. 1895.

||Burger, J.—Abhandlung uber 'ie Naturg. Cultur u. Benutz. des Mais: 242-243. Wien, 1809. Abs. in Bull. Kans. Exper. Sta. no. 62: 191. 1896.

*Burt, W. H.—Monograph on Ustilago maidis, its physicologico-pathological effects, together with its uses in disease. Detroit, (1868?).

*Carradori, G.—Giorn. Pisa 7: 301, and 10: 265.

Chestnut, V. K.—Ann. Rep. Bureau Animal Industry for 1898:388, 393, 419. 1899.

Chevalier, F. F.—Flore gen. environs Paris: 403. Paris, 1826.

*Clos,—Recherches sur le charbon du Mais, Jour. Agric prat. 1871.

Collier, Peter—See Parsons.

Corda, A. K. J.—Icon. fung. 4: 9. 1840. Same 5: 3. 1842.

Cressler, C. H.—On the ergot of Indian corn, Amer. Jour. Pharm. 33: 306-309. 1861.

*Cugini, G.--Sulla vegetazione delle crittogame parassite delle cultivationi, Ann. Soc. Agr. Bologna 16. 1876. Abs. in Nuova Giorn. Bot. Ital. for 1877: 109.

D'Arbois, A. and Vesque, J.—Les Maladies Pl. Cult.: 150-151. Paris, 1878.

DeBary, A.—Unters. uber die Brandpilze: 4-8. 1853.

DeCandolle, A. P.—Phys. vegetale 3: 1453. 1832.

DeCandolle, A. P.—See Lamarck and DeCandolle.

DeToni, J. B.—Saccardo's Sylloge fungorum 7: 473. 1888.

Dorland, W. A. N.—Ustilago maydis, a study of the drug with reference to its employment as an oxytoxic, Med. News 51: 534-536. 1887.

Duby, J. E.—Bot. Gall. 2: 901. Paris, 1830.

Duchesne, E. A.—Traite du Mais ou ble de Turquie: 59-69. Paris, 1833.

||Dulong, M.—Jour. de Pharm. 14: 556. 1828. Abs. in Ann. der Pharm. 1: 178. 1832.

Earle, F. S.—See Underwood and Earle.

Farmers' Bulletin no. 69: 18-20. Washington, 1898.

Figuier, L.—The vegetable world: 269-270. New York, 1867.

*Firth, L. B.—Therap. Gaz. Detroit, 7: 101. 1883.

Fischer, J. L.—See Rademaker and Fischer.

||Fischer de Waldheim, A.—Sur le structure des spores des Ustilaginees, Bull. Soc. Imp. Nat. Moscou. 1867. Abs. in Hedw. 6: 166-170. 1867; Bot. Zeit. 25: 393. 1867.

||Fischer de Waldheim, A.—Beitrage zur Biologie und Entwickelungsgeschichte der Ustilagineen, Pringsh. Jahrb. f. wiss. Bot. 7: —. 1869.

English trans. in Rep. N. Y. Agric. Soc. for 1870: 280-354. 1871. Abs. in Hedw. **9** : 91-95. 1870.

Frank, A. B.—Die Krankheiten der Pflanzen: 431. Breslau, 1880.

Gamgee, J.—Ill effects of smut in the feed of farm animals, Rep. Com. Agric. on Diseases of Cattle in U. S.: 73-81. Washington, 1871.

Georgeson, C. C.—Treating seed corn with creosote for smut, Bull. Kans. Exper. Sta. no. 30: 202-203. 1891.

Giersberg, Fr.—Krankh. d. Landw. Culturpfl.: 23. Berlin, 1878.

||Gibelli, G.—Studii sulla multiplicazione artificiale delle cryttogame parassiti dei cereali, Atti R. Acad. Sci. Modena **17**:—. 1877. Abs. in Just's Bot. Jahresb. for 1877: 97-98. 1879.

Goff, E. S.—Corn smut, Tenth Rep. Wis. Exper. Sta. for 1893: 246-247. 1894.

Hahn, J. H.—Corn smut, Amer. Jour. Pharm. **53**: 496. 1881. Abs. in Just's Bot. Jahresb. for 1881: (Pt. II.) 670. 1884.

Halsted, B. D.—From grain to ear, Rep. Mass. Bd. Agric. for 1882: 79-80. 1883.

Halsted, B. D.— Rep. N. J. Exper. Sta. for 1896: 352. 1897.

||Hartsen,—Sur les caracteres chimiques de l'Uredo du Mais, Compt. rend. 1874: 441-442. Abs. in Just's Bot. Jahresb. for 1874: 248. 1876.

||Haselbach,—Mag. f. Tierheilkunde, von Gurlt u. Hertwig, 1860: —. Abs. in Zurn und Plant's Die pflanzlichen Parasiten auf und in dem Korper unserer Haussaugetiere : 68 footnote. 2nd edition. Weimer, 1887.

Henry, W. A.—Rep. Regents Wis. Univ. for 1881: 46-54. 1882. Abs. in reference to feeding smut to cows in Trans. Wis. Agric. Soc. for 1881-2: 278-280. 1882; Tenth Rep. Wis. Exper. Sta. for 1893: 81-83. 1894; Breeder's Gaz. **26** : 240. 1894.

Henry, W. A.—Corn smut, First Rep. Wis. Exper. Sta. for 1883: 25-27. 1884.

Henry, W. A.—Smut upon corn and timothy, Breeder's Gaz. **14**: 360-361. 1888.

Hickman, J. F.—See Selby and Hickman.

Hitchcock, A. S.—Variation in spores of corn smut, Science 22: 353. 1893.

Hitchcock, A. S. and Norton, J. B. S.—Corn Smut, Bull. Kans. Exper. Sta. no. 62: 162-212. 1896.

Hitchcock, A. S.—Note on corn smut, Bot. Gaz. **'8**: 429-430. 1899.

Humphrey, J. E.—Ninth Rep. Mass. Exper. Sta. for 1891: 246-247.. 1892.

Imhof, J.—Zeae Maydis morbus ad ustilaginem vulgo relatus: 1-36. Argentorati, 1784.

Kellerman, W. A.—Experiments with corn smut, Bull. Kans. Exper. Sta. no. 23: 101-104. 1891.

Knowles, E. L.—Abnormal structure induced by Ustilago Zeae Mays, Jour. Myc. **5** : 14-18. 1889.

Kuhn, J.—Die Krankheiten der Kulturgewachse : 70-76, 260. Berlin, 1858.

Kuhn, J.—Mittheilungen uber die Entwickelungsformen des Getreidebrandes: Halle.

Kuhn, J.—Entwickelungsgeschichte des Maisbrandes, Hedw. **2** : 5-7. 1858.

||Kuhn, J.—Ueber die Entwickelungsformen des Getreidebrandes und die Art des Eindringens der Keimfaden in die Nahrpflanze, Stzber.

d. nat. Ges. Halle, 1874:—; Centr. f. Ag. chem. 1874: 150-153; Bot. Zeit. 1874: 121-124; Just's Bot. Jahresb. for 1874: 247-248. 1876.

*Kuhn, J.—Ueber die an dem Grunmais und Futtersorghum vorkommenden Brandformen. Fuhl. Landw. Zeit. **28**: 81. 1879. Abs. in Just's Bot. Jahresb. for 1879: 564-565. 1883.

Lamarck, J. B. and DeCandolle, A. P.—Fl. Franc. **2**: 596. Same, **3**: 98-99. Paris, 1805.

Lamarck, J. B. and DeCandolle, A. P.—Encyl. Meth. Bot. **8**: 227. Paris, 1808.

Lamarck, J. B. and DeCandolle, A. P.—Fl. Franc. **6**: 77. Paris, 1815.

*Leonard, C. H.—New Preparations. Abs. in Amer. Jour. Pharm. **49**: 189. 1877.

Leveille, J. H.—Recherches sur le developpement des Uredinees, Ann. Sci. Nat. 2nd ser. **11**: 13-14. 1839.

Leveille, J. H.—Sur la disposition methodique des Uredinees, Ann. Sci. Nat. 3rd ser. **8**: 373-376. 1847.

*Leveille, J. H.—Le bon Jardinier for 1855: 249. Abs. in Prillieux's Mal. Pl. Agric. **1**: 174. 1895.

Magnus, P.—Seit wann ist der. Maisbrand in Mittel Deutschland? Deutsch. Bot. Monatsschr. **13**: 49-53. 1895.

Magnus, P.—Die Ustilagineen der Provinz Brandenburg. Abh. bot. Ver. Brand. **18**: 72-73. 1896.

Mayo, N. S.—Bull. Kans. Exper. Sta. no. 58: 68-70. 1896.

*Meyen, F. J. F.—Ueber die Entwicklung des Getreidebrandes in dem Mays Pflanzen. Wiegm. Arch. **3**: 419-421. 1837.

Meyen, F. J. F.—Pflanzen Pathologie: 101-104. Berlin, 1841.

*Miles, C. E.—Ustilago maidis as an oxytocic. Mass. Eclect. Jour. Boston. for 1881: 241-245.

Mitchell, James—Physiological action of Ustilago maidis on the nervous system. Therap. Gaz. Detroit **10**: 223-227. 1886.

Moore, V. A.—Bull. U. S. Bureau Animal Industry no. 10: 11-13, 15-16, 47-49. 1896.

*Morini, F.—Il carbone delle piante, Clin. Veterin. **7**: —. 1884. Abs. in Bot. Centr. **21**: 367. 1885; Sorauer's Handb. d. Pflanzenkr. **2**: 208. 2nd ed. Berlin, 1886; Prillieux's Mal. Pl. Agric. **1**: 174. 1895.

*Morini, F.—Mem. Acad. Sci. Bologna **6**: 283 290 1886. Abs. in Jour. Roy. Micr. Soc. for 1888: 269.

Norton, J. B. S.—A study of the Kansas Ustilagineae especially with reference to their germination, Trans. Acad. Sci. St. Louis, **7**: 234-235. 1896.

Norton, J. B. S.—See Hitchcock and Norton.

Pammel, L. H.—Corn smut, Proc. Iowa Acad. Sci. for 1891, **1**: (P. 2) 95. 1895. Abs. in Bull. Iowa Exper. Sta. no. 16: 315-324. 1892.

Pammel L. H. and Stewart, F. C.—Prevention of corn and oats smut, Bull. Iowa Exper. Sta. no. 20: 726-728. 1893.

Panton, J. H.—Bull. Ontario Agric. Coll. no. 56: 4-6. 1890.

Parmentier, A. A.—Le Mais ou ble de Turquie, Mem. Acad. Roy. Sci. Bordeaux 1784: 31-35. 1785. Same in a separate and revised edition 49-57. Paris, 1812.

Parsons, H. B.—Analysis of corn smut (in report of the chemist, Peter

Collier), Rep. U. S. Dept. Agric. for 1880: 136-138. 1882. Also in New Remedies II: 80-82. 1882.

Peck, Charles H.—Rep. N. Y. Mus. 22: 92-93. 1868. Same. 34: 26-28. 1881.

Peters, A. J.—Corn stalk disease, Bull. Neb. Exper. Sta. no. 52: 52-54. 1898.

*Phillippar, F.—Hist. nat du Mais:—. 1837.

Plowright, C. B.—British Ured. and Ustilagineae: 58-118. London, 1889.

Plumb, C. S.—Diseases, Indian Corn culture: 147-153. Chicago, 1895.

Prillieux, Ed.—Maladies des plantes agricoles, I: 170 175. Paris, 1895.

||Rademaker, C. J. and Fischer, J. L.—Ustilagine, Med. Herald for 1887: 775. Also in Nat. Druggist for 1887: —, and in Jour. Pharm. 18: 156. 1887. Abs. in Journ. de Pharm. et Chem. 16: 359 1887; Amer. Journ. Pharm. 58: 445 1887; Just's Bot. Jahresb. for 1887, Abth. 1: 522 and Abth. 2: 500. 1889.

||Re, F.—Fungo del maiz, Saggio teorico-pratico sulle malattie delle piante: 187. Venezia, 1807. Cited by DeCandolle, Phys. Veg. 3: 1454. Paris, 1832.

||Renner, A.—Ar. uszogbetegseg, Foldm. Erd. 7:—. 1879. Abs. in Just's Bot. Jahresb. for 1879: 564. 1883; Jour. Roy. Micr. Soc. for 1880: —; Amer. Nat. for 1880: 365.

||Roulin, —De l'ergot du Mais et de ses effets sur l'homme et les animaux, Acad. Sci. Paris. 1829. Also in Ann. Sci. Nat. 19: 282. 1830. Abs. in Duchesne's Traite du Mais: 64-67. Paris, 1883.

Satterlee, Jas.—Corn mixed with smut, Rep. Mich. Board Agric. for 1883: 45. 1884.

Schroeter, J.—Krypt. Fl. von Schlesien, Pilze I. 271. Breslau. 1889.

Schroeter, J.—Die Brand und Rostpilze Schlesiens, Abh. d. Schles. Ges. nat. for 1869: —.

Schweinitz, L.—Synopsis, fungorum Carolinae superioris, Schriften d. Nat. Ges. Leipzig I : 71. 1822.

Schweinitz, L.—Synopsis fungorum in America Boreali, Trans. Amer. Phil. Soc. 4: 290. 1834.

Scribner, F. L.—See Seymour.

Selby, A. D. and Hickman, J. F.—Corn smut, Bull. Ohio. Exper. Sta. no. 78: 92-96. 1897.

Seymour, A. B.—Smut of Indian corn (in Report of the section of vegetable pathology by F. L. Scribner), Rep. U. S. Dept. Agric. for 1887: 380-389. 1888.

Seymour, A. B.—Amer. Gard. II: 278. 1890.

Smith, Clinton, D.—Feeding corn smut to dairy cows, Bull. Mich. Exper. Sta. no. 137: 41-46. 1896.

Sorauer, P.—Handbuch der Pflanzenkrankheit: 264-266. Berlin, 1874.

Sorauer, P.—Handb. d. Pflanzenkr. 2. 201-208. 2nd edition. Berlin, 1886

Spalding, V. M.—Ustilago maydis and related species, Therapeutic Gaz. Detroit 5: 121-125. 1881. Abs. in Just's Bot. Jahresb. for 1881: 691. 1884.

Stewart, F. C.—Effects of heat upon the germination of corn and smut, Proc. Iowa Acad. Sci. for 1894, 2: 74-78. 1895.

Stewart, F. C.—See Pammel and Stewart.

Stuart, Wm.—Fungicides for the prevention of corn smut, Proc. Ind.

Acad. Sci. for 1895; 96-99. 1896.

*Swiecicki—Ustilago maidis in der Geburtshulfe, Therap. Monatschr. 2: 171. Berlin, 1888.

*Taylor, Robert A.—Inaug. Thesis Jefferson Med. College, 1886.

Thomas, M. B.—Some field experiments with formalin, Proc. Ind. Acad. Sci, for 1898: 62-64. 1899.

Tillet, M.—Observation sur la maladie du Mais ou ble de Turquie, Mem. Acad. Sci. Paris for 1760: 254-261. 1766. Abs. in Hist. Acad. Sci. Paris for 1760: 85-89. 1766. (The Histoire and Memoires of this year form one volume with a single title page and table of contents, but separately paged. The volume is without number.) German trans. by Beckmann, Hannov. Mag. 6:1329-1340. 1768.

Trelease, Wm.—Beal's Grasses of N. Amer. 1:414. 1887.

Tubeuf, C. v.—Zeitschr. f. Pflanzenkr. 3:203. 1893.

Tulasne, L. and C. H.—Ann. Sci. Nat. 3rd ser. 7:14-126. 1817.

Underwood, L. M. and Earle, F. S.—Treatment of some fungous diseases, Bull. Ala. Exper. Sta. no. 69: 253-254. 1896.

Unger, F.—Die Exantheme der Pflanzen: 350. Wien, 1833.

Unger, F.—Ueber der Einfluss des Bodens: 211. Wien, 1836.

Unger, F.—Anat. und Phys. d. Pflanz: 129. 1855.

Utz, Henry B.—A treatise on a new and infallible mode of improving the quality of Indian corn: 4-5. Corydon, Indiana, 1894.

Wallroth, K. F. W.—Fl. Crypt. Germ.: 215. 1833.

Ward, Marshall H.—Smut fungi, Gard. Chron. for 1889: 233-235, 267-268.

Winter, G.—Krankh. der Kultur-Gewachse: 129-130. Leipzig, 1878.

Winter, G.—Rabenh. Krypt. Fl. Deutschl. Pilze 1:97. 1881.

Wolff, R.—Der Brand des Getreides. Inaug. Diss. 10-11, 18-24. Halle, 1874. Abs. in Just's Bot. Jahresb. for 1873: 84-86. 1874.

Wolff, R.—Krankh, der landw. Nutzpfl.: 44. Berlin, 1887.

Wood, H. C.—Ustilago, Dispensatory of U. S. of Amer.:1766. 17th ed. Philadelphia, 1896.

To the above list of citations may be added the following references to more ephemeral publications, mostly agricultural. These contain matter of more or less value relating to corn smut, in part written by persons uninformed regarding the opinions of scientific men.

Amer. Agriculturist 39:447 188‵. 40:319 1881.

Amer. Corn and Hog Journal, No. 8, 1895.

Amer. Epitomist, March, 1893.

Amer. Farmer, Sept., 1861.

Amer. Gardening, 9:289. 1890. 11:241. 1891

Breeder's Gaz. 26:340. 1894. 28:327. 1895.

Country Gentleman, 25:43, 125. 1865. 32:275. 1868. 34:275 1869. 41:549, 795. 1876. 43:584. 1878. 45:76, 107, 139, 236. 1880. 46:579, 1881. 55:123. 1890 57:187. 1892.

Farmer's Guide for 1898: 642.

Ind. Agric. Report for 1856: 354. 1890: 163-165.

Indianapolis Jour., Dec. 9, 1898.

Mass. Agric. Report for 1876-7: 162. 1880: 99-101, 106. 1889: 206.

Mich. Agric. Report for 1850: 118. 1857: 261, 272. 1884:200.

Ohio Agric. Report for 1878: 345-346.

Pop. Gardening, 3:276 277. 1887 8. 4:208. 1888 9.

LIST OF TREES AND SHRUBS ON THE GROUNDS OF PURDUE UNIVERSITY

This list is published as of special interest, in view of the fact that the winter of 1898-99 was one of the severest in many years, on trees in Indiana. All the trees, shrubs and vines enumerated below withstood the severity of the worst weather.

Arranged by Pierre Van Landeghem, University Florist and Landscape Gardener.

Deciduous Trees.

Generic and specific names.	English or common names
Acer campestris	Maple, European.
Acer dasycarpum	Maple, American Silver.
Acer ginnale	Maple, Small Leaved, Siberian.
Acer platanoides	Maple, Norway.
Acer pseudo platanus	Maple, Sycamore.
Acer rubrum	Maple, Red or Swamp.
Acer saccharinum	Maple, Sugar or Rock Maple.
Acer Schwedlerii	Maple, Purple Norway.
Acer Wierii	Maple, Silver Cut-Leaved.
Ailanthus glandulosa	Japanese Tree of Heaven.
Castanea Americana	Sweet Chestnut.
Æsculus glabra	Horse Chestnut.
Æsculus flava	Yellow Buckeye.
Betula alba	Birch, European White.
Betula alba laciniata	Birch, Eu. Silver Cut-Leaved Weeping.
Betula lutea	Birch, American Yellow.
Betula papyracea	Birch, American Paper Barked Canoe.
Betula atropurpurea	Birch, European, Purple Leaved.
Betula rubra	Birch, American Red Barked.
Carya amara	Hickory, American Bitternut Hickory.
Catalpa Kampferii	Japanese Catalpa.
Catalpa speciosa	Western Catalpa.
Celtis occidentalis	Amer. Nettle tree..
Cercis Canadensis	Judas Tree.
Cladrastis tinctoria	American Yellow Wood.
Crataegus coccinea	American White Thorn.
Elaeagnus hortensis	American Silver Thorn.
Fagus Americana	American Silver Beech.
Fagus Riversii	American Blood Leaved Beech.
Fraxinus Americana	American White Ash.
Fraxinus excelsor	English Ash.
Fraxinus ornus	English Flowering Ash.
Fraxinus quadrangulata	American Blue Ash.
Fraxinus sambuscifolia	American Black Ash.
Fraxinus viridis	American Green Ash.
Gleditschia triacanthos	American Honey Locust.
Gymnocladus Canadensis	American Kentucky Coffee Tree.

DECIDUOUS TREES—(Continued)

Generic and specific names.	English or common names
Juglans cinerea	American Butternut.
Juglans nigra	American Black Walnut.
Larix Europea	European Larch.
Liriodendron tulipifera	Amer. Tulip Tree, White Wood, Poplar.
Liquidambar styraciflua	American Sweet Gum.
Magnolia acuminata	American Cucumber Tree.
Morus alba	American Mulberry.
Negundo aceroides	American Ash Leaved Maple.
Nyssa multiflora	American Sour Gum.
Ostrya Virginica	American Ironwood.
Planera cuspidata	American Elm Leaved Plane.
Platanus orientalis	Eastern Plane Sycamore.
Populus alba	American Silver Poplar.
Populus balsamifera	American Balsam Poplar.
Populus bolleana	American Silver Barked Poplar.
Populus fastigiata	European Lombardy Poplar.
Populus monilifera	American Necklace Poplar.
Populus tremuloides	American Aspen Poplar.
Pyrus aucuparia	European Mountain Ash.
Quercus alba	American White Oak.
Quercus coccinea	American Scarlet Oak.
Quercus macrocarpa	American Mossy Cup or Burr Oak.
Quercus palustris	American Pin or Water Oak.
Quercus tinctoria	American Black Oak.
Rhamnus cathartica	American Common Buckthorn.
Robinia hispida	American Rose Acacia.
Salisburia adiantifolia	Japanese Gingko or Maiden Hair Tree.
Salix babylonica	Babylonian Weeping Willow.
Salix pentandra	European Laurel Leaved Willow.
Salix discolor	Pussy Willow.
Prunus serotina	American Wild Black Cherry.
Sophora japonica	Japanese Sophora, Green Barked.
Tilia Americana	American Linden or Basswood.
Tilia Europea	European Linden.
Tilia Europea argentea	European Linden, Silver Leaved.
Tilia platyphylla	American Linden, Large Leaved.
Tilia rubra laciniata	European Linden, Red Tinged.
Ulmus Americana	American White Elm.
Ulmus campestre	European English Elm, Small Leaved.
Ulmus fulva	American Slippery or Red Elm.
Ulmus racemosa	American Cork Elm or Rock Elm.
Xanthoxylum fraxineum	American Prickly Ash.

DECIDUOUS SHRUBS AND VINES.

Generic and specific names.	English or common names
Akebia quinata	Japanese Five Leaved Akebia.
Ampelopsis quinquefolia	American Virginia Creeper or Ivy.
Ampelopsis Veichii	Japanese Five Leaved Ivy.
Amygdalis nana	Russian Flowering Almond.
Berberis purpurea	European Purple Barberry.
Berberis vulgaris	American Common Barberry.
Calycanthus floridus	American Sweet Scented Shrub.
Caragana arborescens	Siberian Yellow Pea.
Celastrus scandens	American Bittersweet.
Chionanthus Virginica	Amercan White Fringe.
Clematis flamula	European Sweet Virgin Bower.
Clematis Jackmanii	European Purple Virgin Bower.
Colutea arborescens	European Bladder Senna.
Corchorus Japonica	Japanese Yellow Flowering Kerria.
Cornus Japonica	Japanese Yellow Flowering Kerria,
Euonymus sanguinea	English Red Twigged Dogwood.
Forsythia atropurpurea	American Burning Bush.
Forsythia Fortunii	Chinese Golden Bell.
Forsythia viridissima	Chinese Golden Bell.
Halesia tetraptera	American Silver Bell.
Hibiscus syriacus	Syrian Rose of Sharon.
Hibiscus ranunculaeflora	Syrian Rose of Sharon.
Hydrangea paniculata	American Hydrangea.
Ligustrum vulgare	American Privet.
Lonicera grandiflora	Russian Honeysuckle.
Lonicera tartarica	Tartarian Honeysuckle.
Lonicera xylosteum	English Fly Honeysuckle.
Paeonia Banksia	Chinese Purple Paeony.
Paeonia rosea	Chinese Pink Paeony.
Philadelphus coronarius	European Mock Orange.
Philadelphus grandiflora	Carolina Mock Orange.
Pyrus Japonica	Japonica. Japanese Quince.
Ribes aureum	American Yellow Flowering Currant.
Spiraea prunifolia	Chinese Prune Leaved Spiraea.
Spiraea Reevesii	European Reeve's White Spiraea.
Spiraea salicifolia	European Willow Leaved Spiraea.
Syringa Emodii	American Pink Flowering Spiraea.
Spiraea Van Houttii	Eu. Spirea. Van Houtte's White Spiraea
Styrax Japonica	Japanese White Flowering Styrax.
Syringa alba	Persian White Lilac.
Syringa Emodii	Himalayan White Lilac.
Syringa Lemoinii	Persian Hybrid Lilac.
Syringa Persica	Persian Purple Lilac.
Syringa vulgaris	Persian Common Lilac.
Viburnum opulus sterilis	European Common Snow Ball.
Viburnum plicatum	Japanese Snow Ball.
Weigela rosea	Chinese Rose Flowering Weigela.

EVERGREEN OR CONIFEROUS TREES.

Generic and specific names.	English or common names
Abies balsamea	American Balsan Fir.
Juniperus Canadensis	American Hemlock Spruce.
Picea excelsa	Norway Spruce.
Pseudotsuga pungens	Colorado Blue Spruce.
Picea Douglasii	Douglas Spruce.
Pinus Virginiana	American Red Cedar.
Pinus austriaca	European Austrian Pine.
Pinus cembra	Siberian Pine.
Pinus densiflora	Japanese Pine.
Pinus excelsa	Asia Bhotan Pine.
Pinus inops	American Jersey Pine.
Pinus strobus	American White Pine.
Thuya sylvestris	European Scotch Pine.
Thuya globosa	American Globe Arbor Vitae.
Thuya occidentalis	American Arbor Vitae.
Thuya Siberica	Siberian Arbor Vitae.

DESCRIPTION OF EXPERIMENT STATION PIGGERY.

By H. E. VanNorman.

The new piggery is located on the highest ground in lot C. of field 3, as shown on the farm map, corrected to November, 1898. The building occupies the south part of the lot and faces north.

The main part of the building is 22 by 46 feet outside. The long way north and south. On each side is a wing 12 by 14 feet.

From the front door a central alley, 6 feet wide, extends the entire length of the building. On the right of this alley the first 18 feet is given up to feed chutes, mixing vat, scales for weighing experimental feed, water hydrant and a 5x6 foot Howe stock scale.

The remainder of the space on this side of the alley is divided into four feeding pens, each 7x8 feet.

Beginning at the front door, on the left, is a stairway leading to the second floor. Next, a room 8x11 feet, extending under the stairway, is fitted for an attendant to be comfortable at night, if necessary for him to stay with a farrowing sow. This room contains a stove and boiler for heating water and cooking feeds and it also affords place for pails, brooms, etc., and has a brick chimney.

The next space, 9x8 feet, is ceiled up to the ceiling, making a tight warm room for sows to furrow in. A window opens into the attendant's room. The remaining space on this side of the alley is divided into four pens, 7x8 feet, corresponding to the west side.

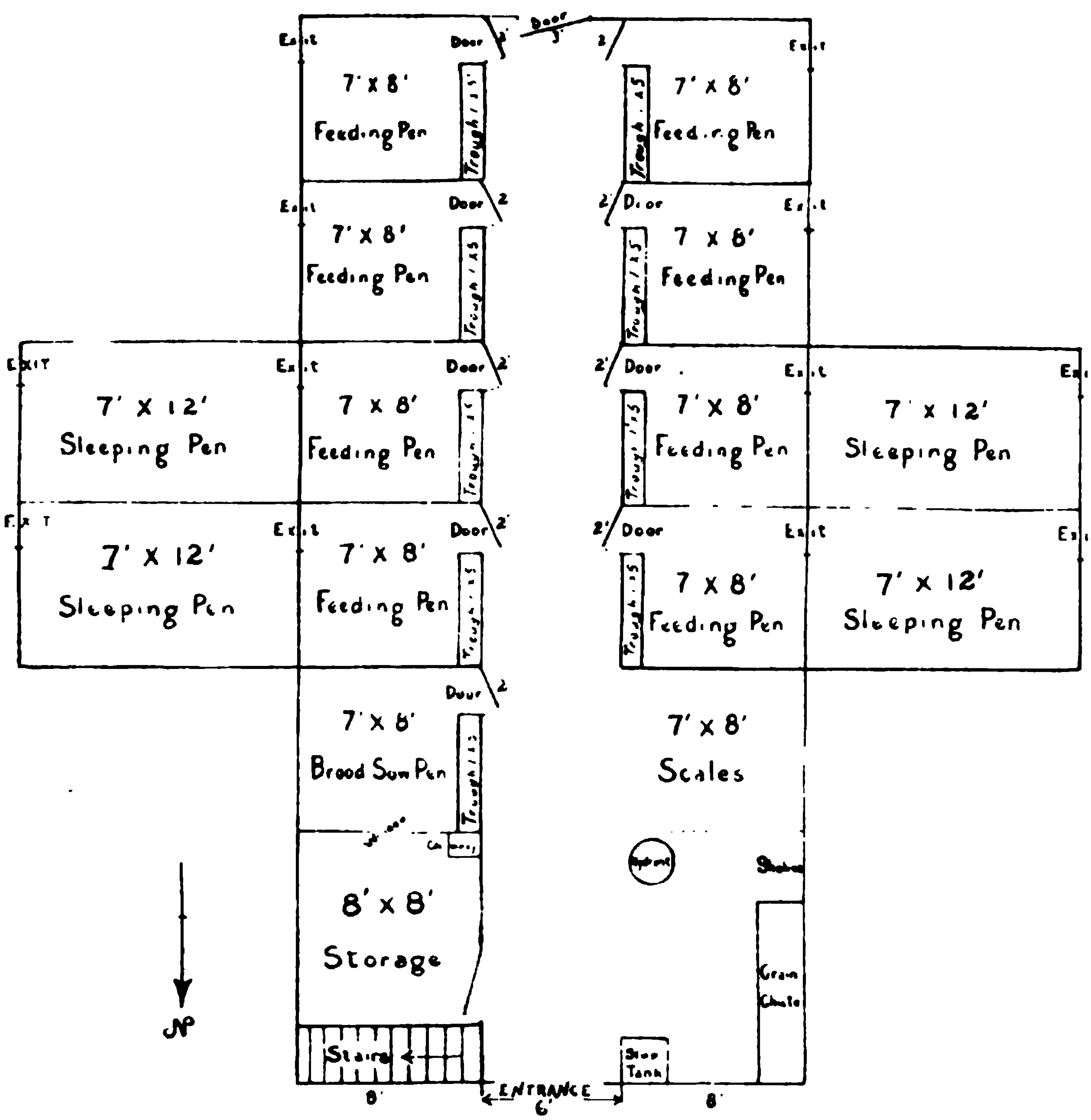
The wings on either side are divided into two pens 7x12 feet, are used for sleeping pens and open into the first two feeding pens. For the remaining pens sleeping quarters are provided in small shelter houses in each lot.

The front part, 22x32 feet, of the main building is two stories high, affording storage room for bedding, crates and bin room for feed. The remainder of the building, including wings, is one story high.

The foundation is of brick, 8 inches thick, and 18 inches deep, with the top just above the ground. The sills are 4x8 inches, No. 1 pine, while the studs are 2x6 inch No. 1 hemlock, 14 feet long, for the two story part, 2x4 inch 7 feet long for the one story part and 4½ feet long for the wings.

On the studding of the wings are nailed plain boards. On these is put No. 3 tarred building paper, over which the yellow pine drop siding is nailed. The remainder of the building has the same drop siding without any lining.

The rafters are laid 2 feet apart, from center to center, and are No. 1 hemlock, 2x4 inches, 16 fet long. The plate is 2x6 inch No. 1 hemlock, with 2x4 inch hemlock on top, the two spiked together. The rafters are tied with cross braces 3 feet below the comb of the roof. There is also one tie rod through the center of the building to hold the plates from spreading.



Floor Plan of Piggery at Purdue University.

The floor of the main building is of cement three inches thick. The bottom $2\frac{1}{2}$ inches is grout made with Louisville cement, while the top $\frac{1}{2}$ inch is made with Portland cement. There are two gutters extending the length of the feeding pens, just inside of the front partition and emptying into the tile drains at the south end of the building.

There are three windows on the east side, two in each end and the west side and one on each north and south side of the wings.

These windows are all transom shape, having four panes of glass 10x12 inches, and hinged on the bottom side, opening in. The second story front has two windows of standard shape and size. There is also a door to receive feed onto this floor.

The front door downstairs is double, each being 3x6½ feet. The rear door is 4x6 feet.

The partitions between the pens are three feet high, made of ⅞x6 inch hard pine flooring, nailed vertically on 2x4 inch oak stringers. The front partition on the west of the alley is the same as that between the pens, while the east side front is put on horizontally. The bottom four boards are cleated together and make a door which hung from the top permits it to be swung in to facilitate cleaning the floor and gutter.

Each pen has a door opening into the alley. These are plain batten doors uniform with the partitions. At the rear of each pen a door opens into the sleeping quarters, or lot, as the case may be. These are slide doors and are lifted by means of a rope running over pulleys to the front of the pen. Each pen has a galvanized iron, half round feeding trough. These troughs are 5 feet long, one foot wide, and 6 inches deep, are bound together with angle iron and have two strips of strap iron across the top to prevent spreading. These troughs are hinged to the front partiton on the west side of the alley and to the swinging partition on the east side of the alley. This arrangement permits the easy cleaning of the floor and gutter.

The grain bin occupies a space 3½x8 feet on the second floor. It is 4 feet deep and has a cover. From the second floor line the front of the bin continues down to within 3 feet of the floor and 6 inches from the wall, leaving an opening 6 inches wide and 8 feet long. Six inches below this opening is a box 2 feet wide and 8 feet long, into which the feed empties, and from which it may be scooped out. This bin is divided into four compartments by means of three partitions extending from the top of the bin to the box below. In these bins all the feed will come down within reach of the feeder's scoop as it is removed from below.

On the roof of the building there is a cupola, with ventilating blinds. Extending from below the ceiling of the first story up into this cupola is a ventilating shaft 10x10 inches. It has a slide cut off to regulate the draft.

The building is fully equipped with gutters, down-spouts, and drainage.

The building is so placed as to be centrally located among a

series of feeding lots, all of which are connected with the building by lanes leading up to it. Each lot contains a small house for sleeping quarters. See plate XIV.

Water is piped into the building from a central supply tank.

This building is not necessarily a model for the feeder or breeder of hogs, as it was designed to meet the needs of the Experiment Station in its experimental feeding work. The general construction, however, offers numerous helpful suggestions to the pig feeder, and from the sanitary and economic standpoints it presents a very desirable type of construction. Many details are the result of consultation and correspondence with some of the most successful swine breeders in the United States, and in so far as any of the details may meet the needs of the farmers or breeders, they are models, though the arrangement of the building as a whole may not be.

APPENDIX.

The following gifts have been made to the Station during the year, and to the givers of these, thanks are herewith rendered:—

W. H. Caldwell, Sec'y, Petersboro, N. H., Herd Register American Guernsey Cattle Club, Vol. 8.

F. L. Houghton, Sec'y, Brattleboro, Vt., Vol. XV, Holstein-Friesian Herd Book of America.

Alfred Mansell, Sec'y, Shrewsbury, England. Vol. XVI, English Shropshire Flock Book.

Carl Friegau, Sec'y, Dayton, Ohio. Vol. XX, Ohio Poland China Record.

A. P. Grout, Winchester, Ill. One Collie dog.

J. McLain Smith, Sec'y, Dayton, Ohio. Vol. X, Red Polled Cattle Herd Book.

C. R. Thomas, Sec'y, Independence, Mo. Vol. XIX, American Hereford Record.

Frank B. Hearne, Sec'y, Independence, Mo. Vols. V, VI, VII, VIII, IX, American Galloway Cattle Herd Book.

Robert J. Evans, Sec'y, El Paso, Ill. Vols. I, II, III, IV, National Duroc-Jersey Record.

A. V. Bradrick, Sec'y, Connersville, Ind. Vol. VIII, American Duroc-Jersey Record.

Herbert A. Jones, Sec'y, Himrods, N. Y. Vol. A, International Ohio Improved Chester White Swine Record.

Farmers' Guide Pub. Co., Huntington, Ind., Bound Copy of Vol .IX, Farmers' Guide for 1897.

Propaganda for the Use of Nitrate of Soda, New York City. Two sacks nitrate of soda.

Edward Sudendorf, Ag't, Elgin, Ill. One quart Wells-Richardson Butter color.

W. Atlee Burpee, Philadelphia, Pa. Collection of varieties of flower and vegetable seeds.

B. F. Harris, Dull, Tenn. Package Harris' Earliest Watermelon seed.

S. J. Lehman & Co., Enon, Ind. 25 Lehman's No. 2 strawberry plant.

American Stock Food Co., Chicago, Ill. 100 lbs. American stock food.

Crown M'f'g Co., Phelps, N. Y. Repairs for Crown drill.

Henry E. Dooch, Sec'y, Portland, Oregon. Fifth Biennial Report Oregon State Board of Horticulture.

L. A. Godman, Sec'y, Westport, Mo. 41st Annual report Missouri State Horticultural Society.

German Kali Syndicate, New York City. Muriate of potash.

Wm. Henry Maule, Philadelphia, Pa. New seeding potato, No. XXX

C. W. Middleton, Utica, Mo. 12 Livingston. Raspberry plants.

Luther Burbank, Santa Rosa, Cal. Scions of Apple Plum, American Plum and Chalco Plum.

W. J. Hurst, Muncie, Ind. Seedling potatoes.

C. S. Pratt, Reading, Mass. 12 samples strawberry plants.

Amos Garretson, Pendleton, Ind. Eaton Raspberry plants.

J. H. Marion, Fulton, Mo. Seeds and scions of native persimmon.

W. D. Latshaw, Carlisle, Ind. Six Hoosier blackberry plants .

C. E. Wilkinson, Carmel, Ind. Six Admiral Blackberry plants.

Mr. Riehl, Alton, Ill. Eight varieties seedling strawberries.

United States Department of Agriculure, Washington, D. C. Numerous plants, seeds, etc., for trial, sent from different Divisions. Also numerous publications.

UNITED STATES PERIODICALS.

The publishers of the following periodicals have generously sent them free of cost to the Station during the year. These are leading journals and are used frequently by both the Station employès and University students.

American Agriculturist	New York, N. Y.
Agricultural Epitomist	Indianapolis, Ind.
American Creamery	Chicago, Ill.
American Gardening	New York, N. Y
American Grange Bulletin	Cincinnati, Ohio.
American Horticulturist	Wichita, Kansas.
American Sheep Breeder and Wool Grower	Chicago, Ill.
American Swineherd	Chicago, Ill.
Baltimore Sun (weekly)	Baltimore, Md.
Beet Sugar Gazette	Chicago, Ill.
Breeder's Gazette	Chicago, Ill.
California Cultivator	Los Angeles, Cal.
Colman's Rural World	St. Louis, Mo.
Creamery Gazette	Des Moines, Iowa.
Creamery Journal	Waterloo, Iowa.
Dairy and Creamery	Chicago, Ill.
Dakota Field and Farm	Sioux Falls, S. D.
Drainage Journal	Indianapolis, Ind.
Elgin Dairy Report	Elgin, Ill.
Experiment Station Record	Washington, D. C.
Farm and Dairy	Ames, Iowa.
Farm and Fireside	Springfield, Ohio.
Farm and Home	Chicago, Ill
Farm, Field and Fireside	Chicago, Ill.
Farm Journal	Philadelphia, Pa.
Farm Poultry	Boston, Mass.
Farmers' Call	Quincy, Ill.
Farmers' Guide and Home Companion	Huntington, Ind.
Farmers' Home	Dayton, Ohio
Farmers' Magazine	Springfield, Ill.
Farmers' Review	Chicago, Ill.
Farmers' Tribune	Des Moines, Iowa.
Farmers' Voice	Chicago, Ill.
Farm, Furnace and Factory	Roanoke, Va
Field and Farm	Denver, Colo.
Gazette (weekly)	Cincinnati, Ohio.
Grange Visitor	Lansing, Mich.
Home and Farm	Louisville, Ky.

Hospodarske Listy.....................................Chicago, Ill.
Indiana Farmer.....................................Indianapolis, Ind.
Iowa Homestead.....................................Des Moines, Iowa.
Jersey Hustler.....................................Connersville, Ind.
Journal of Agriculture.....................................St. Louis, Mo.
Kansas Farmer.....................................Topeka, Kansas.
Live Stock Journal.....................................Indianapolis, Ind.
Live Stock Report.....................................Chicago, Ill.
Louisiana Planter.....................................New Orleans, La.
Market Garden.....................................Minneapolis, Minn.
Mirror and Farmer.....................................Manchester, N. H.
Montana Fruit Grower.....................................Missoula, Mont.
National Stockman and Farmer.....................................Pittsburg, Pa.
National Farmer and Stockman.............National Stock Yards, Ill.
National Fruit Grower.....................................St. Joseph, Mo.
Nebraska Farmer.....................................Lincoln, Neb.
New England Farmer.....................................Boston, Mass.
New England Florist.....................................Boston, Mass.
New York Produce Review.....................................New York, N. Y.
North American Horticulturist.....................................Monroe, Mich.
Ohio Farmer.....................................Cleveland, Ohio
Oregon Agriculturist.....................................Portland, Ore.
Our Horticultural Visitor....Kinmundy, Ill., and Benton Harbor, Mich.
Pacific Coast Dairyman.....................................Tacoma, Wash.
Pacific Rural Press.....................................San Francisco, Cal.
Practical Dairyman.....................................Indianapolis, Ind.
Practical Farmer.....................................Philadelphia, Pa.
Prairie Farmer.....................................Chicago, Ill.
Progressive South.....................................Richmond, Va.
Public Ledger (daily).....................................Philadelphia, Pa.
Reliable Poultry Journal.....................................Quincy, Ill.
Rural Northwest.....................................Portland, Oregon.
Ruralist.....................................Gluckheim, Md.
Southern Farm Magazine.....................................Baltimore, Md.
Southern Planter.....................................Richmond, Va.
Southern States.....................................Baltimore, Md.
Southwest.....................................Springfield, Mo.
St. Paul Dairy Report.....................................St. Paul, Minn.
Success with Flowers.....................................West Grove, Pa.
Sugar Beet.....................................Philadelphia, Pa.
Swine Breeders' Journal.....................................Indianapolis, Ind.
Tippecanoe Farmer.....................................LaFayette, Ind.
Up to date Farming.....................................Indianapolis, Ind.
Wallace's Stockman and Farmer.....................................Des Moines, Iowa.
Western Creamery.....................................San Francisco, Cal.
Western Fruit Grower.....................................St. Joseph, Mo.
West Virginia Farm Review.....................................Charleston, W. Va.
Wisconsin Agriculturist.....................................Racine, Wis.

INDIANA PERIODICALS.

Advertiser	Medaryville.
Banner	Bluffton.
Columbia City Mail	Columbia City.
Democrat	Salem.
Home Journal	LaFayette.
Hoosier State	Newport.
LaFayette Commercial Gazette	LaFayette.
Lyons' Herald	Lyons.
Magnet	Angola.
Mennonitische Rundschau	Elkhart
News	Monon.
Recorder	Rising Sun.
Register	Crown Point.
Silent Hoosier	Indianapolis.

FOREIGN.

Agricultural Gazette of New South Wales	Sidney, Australia.
Cooperative Farming	Sussex, N. B.
Deutsche Landwirthschaftliche Wochenchrift	Berlin, Germany.
Farmers' Advocate	London, Canada.
Farming	Toronto, Canada.
Mark Lane Express	London, England..
LaProduccion Argentina	Buenos Ayres, Arg. Rep.

Besides the above, the following periodicals are subscribed for by the Station and are on file for reference:

American Veterinary Review	New York, N. Y.
Berichte der Deutschen Botanischen Gesellschaft	Berlin, Germany.
Botanisches Centralblatt	Cassel-Marburg, Germany.
Botanische Zeitung	Leipzig, Germany.
Bulletin de la Societe Chemique de Paris	Paris, France
Centralblatt fur Bakteriologie	Jena, Germany
Entomologist, The	London, England.
Gardeners' Chronicle, The	London, England.
Journal fur Landwirthschaft	Berlin, Germany
Journal of Comparative Medicine	Philadelphia, Pa.
Journal of the Royal Agricultural Society of England	London, England.
Journal of the Chemical Society	London, England.
Live Stock Journal, The	London, England.
Veterinary Journal, The	London, England.
Veterinarian, The	London, England.
Zeitschrift fur Analytische Chemie	Weisbaden, Germany.

TREASURERS' REPORT EXPERIMENT STATION.

As Treasurer of Purdue University, I hereby submit my report of all moneys received during the year, ending June 30, 1899, on account of Experiment Station funds:

From United States Government..................	$15,000.00
From farm receipts..............................	1,587.42
Total	$16,587.42

JAMES FOWLER,
Treasurer Purdue University.

FINANCIAL STATEMENT.

The Agricultural Experiment Station of Indiana, in account with the United States, for the year ending June 30, 1899.

DEBIT.

Received of the Treasurer of the United States, receipts as shown by the Treasurer's report.........$15,000.00

CREDIT.

Salaries	$ 8210.54	
Labor	3171.12	
Publications	702.49	
Postage and stationery	67.11	
Freight and express	78.51	
Heat, light and water	331.93	
Chemical supplies	143.50	
Seeds, plants and sundry supplies	530.89	
Fertilizers	9.93	
Feeding stuffs	255.90	
Library	116.71	
Tools, implements and machinery	443.85	
Furniture and fixtures	9.30	
Scientific apparatus		
Live stock	363.00	
Traveling expenses	42.05	
Contingent expenses	16.21	
Building and repairs	506.96	
Total	$15,000.00	15,000.00

I hereby certify that the above is a correct statement of expenditures in Station Fund for the year ending June 30, 1899.

E. A. ELLSWORTH,
Secretary Board of Trustees.

Improvement Fund, Experiment Farm for Year Ending June 30, 1899.

DEBIT.

Balance, June 30, 1898		$ 973.91
Receipts from farm for year ending June 30, 1899		1587.42

CREDIT.

By salaries	$855.26	
By labor	648.81	
By publications	150.36	
By postage and stationery	8.77	
By freight and express	9.00	
By heat, light and water	105.19	
By chemical supplies	2.80	
By seeds, plants and sundry supplies	126.55	
By feeding stuffs	72.75	
By tools, implements and machinery	44.25	
By furniture and fixtures	6.00	
By scientific apparatus	5.00	
By live stock	21.02	
By traveling expenses	2.16	
By contingent expenses	82.83	
By building and repairs	6.00	
By balance	414.58	
	$2561.33	$2561.33

I hereby certify that the above is a correct statement of expenditures from Improvement Fund for year ending June 30, 1899.

E. A. ELLSWORTH,
Secretary Board of Trustees.

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PURDUE UNIVERSITY.

Thirteenth Annual Report

of the

Indiana Agricultural Experiment Station

LAFAYETTE, INDIANA.

For the year ending June 30, 1900.

PRESS OF
HOME JOURNAL COMPANY.
LAFAYETTE, IND.
1901.

PURDUE UNIVERSITY.

Thirteenth Annual Report

of the

Indiana Agricultural Experiment Station

LAFAYETTE, INDIANA.

For the year ending June 30, 1900.

PRESS OF
HOME JOURNAL COMPANY,
LAFAYETTE, IND.
1901.

To the Governor:

I herewith transmit the annual report of the Purdue University Agricultural Experiment Station for the year ending June 30, 1900.

Very respectfully yours,

WILLIAM V. STUART,

President of the Board of Trustees.

January 3, 1901.

To the President of the Board of Trustees:

I herewith present the thirteenth annual report of the Agricultural Experiment Station of Indiana for the year ending June 30, 1900, the same being required by Section 3, of an act entitled, "An act to establish agricultural experiment stations in connection with the colleges established in the several states, under provisions of an act approved July, 1862, and of the acts supplemental thereto," and being in accordance also with the instructions of the Department of Agriculture.

This report consists of a report of the Director of the Station, and a financial report of the Secretary to the Board of Trustees.

WINTHROP E. STONE,

President.

January 3, 1901.

BOARD OF CONTROL.

William V. Stuart, President........LaFayette, Tippecanoe Co.
William A. Banks......................LaPorte, LaPorte Co.
Sylvester Johnson......................Irvington, Marion Co.
David E. Beem..........................Spencer, Owen Co.
Job H. VanNatta.................LaFayette, Tippecanoe Co.
Benjamin Harrison.................Indianapolis, Marion Co.
William H. O'Brien.............Lawrenceburg, Dearborn Co.
James M. Barrett....................Fort Wayne, Allen Co.
Charles Downing...................Greenfield, Hancock Co.

Edward A. Ellsworth, *Secretary*.
James M. Fowler, *Treasurer*.

STATION STAFF.

James H. Smart, L.L.D., *President**
Winthrop E. Stone, A. M., Ph. D., *Acting President*.

Charles S. Plumb, B. S............................Director.
William C. Latta, M. S........................Agriculturist.
James Troop, M. S...........................Horticulturist.
Henry A. Huston, A M., A. C......................Chemist.
Joseph C. Arthur, D. Sc.........................Botanist.
Arvill W. Bitting, M. D., D. V. M...............Veterinarian.
William Stuart, M. S.....................Assistant Botanist.
A. Hugh Bryan, B. S., A. C...............Assistant Chemist.
John Harrison Skinner, B. S..........Assistant Agriculturist.
H. E. VanNorman, B. S...Farm Superintendent and Assistant.

*Died Feb. 21, 1900.

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THIRTEENTH ANNUAL REPORT

OF THE

Purdue University Agricultural Experiment Station

FOR THE YEAR ENDING JUNE 30, 1900.

REPORT OF THE DIRECTOR.

To President W. E. Stone:

Sir:—I take pleasure in herewith submitting to you the thirteenth annual report of this Station, covering the year ending June 30, 1900.

The work of the Station has been continued along the same lines as heretofore, with no essential change. In the Chemical Department sugar beet investigations have received the larger share of attention, and a large amount of seed was distributed this spring to beet growers in northern Indiana. In the Veterinary Department two subjects have received special attention over all others, viz: hog cholera, and a disease among sheep which seems new to this region, yet which has been prevalent this spring over northwestern Indiana, which has been termed "influenza." This malady has been attended with much fatality, and thus far no satisfactory method of treatment has been determined by our veterinarian. In the Botanical Department special emphasis has been laid on pot culture work to determine the most desirable application of plant food to growing vegetables and flowering plants, and mushroom culture has received attention in the pit provided for that purpose. The opportunities for investigation in each of these fields are of a very superior sort. In this connection it will be desirable for the Station to provide itself with a more permanent mushroom cellar at no far distant day, our present one being of too temporary a character. In the work with field crops no change has been attempted, but the work on forage plants has been somewhat elaborated on, this

being a subject of considerable interest to Indiana farmers. The horticultural work remains much as usual in character. In the Live Stock Department special emphasis is being given to the feeding of swine. The new feeding house is proving itself to be well suited to our work, and pig feeding experiments are in constant progress.

Among the subjects under investigation by the different departments of the Station, the following essentially include all:

1. The influence of protein food on growing chickens.
2. Feeding condimental food to pigs.
3. Feeding sugar beets to pigs.
4. Dry versus moist food for pigs.
5. Feeding value of dried distillers' grains for horses.
6. Hill and drill planting of corn.
7. Deep and shallow cultivation of corn.
8. Deep and shallow planting of corn.
9. Thick and thin planting of corn.
10. Breeding and selection of corn.
11. Rotations, including corn, with and without fertlizers and manures.
12. Variety tests of oats.
13. Rotations including oats.
14. Variety tests of wheat.
15. Tests of mixed seeds of wheat.
16. Tests for treatment for smut of wheat.
17. Rotations including wheat.
18. Methods of planting cow peas and and soy beans.
19. Tests of varieties of cow peas and soy beans.
20. Tests of grasses and clovers.
21. On the value of chemical fertilizers for greenhouse crops, especially tomatoes, lettuce, radishes and chrysanthemums.
22. Sub-watering as applied to greenhouse crops.
23. On the use of formalin as a fungicide, especially for the smuts.
24. A study of the rusts, especially those affecting cultivated plants.
25. The action of corn smut on the animal system.
26. The "damping off" of sugar beets.
27. Mushroom culture in pits.
28. The epidemiology of hog cholera.
29. Prevalence of sheep scab.
30. Serum treatment of tetanus.

31. Clinical features of influenza.

32. The period of gestation.

33. Miscellaneous observations upon diseases as occurring in clinics.

34. Spraying, and the effects of different insecticides and fungicides.

35. Close root pruning and its effect on different trees.

36. The effect of climate on forest tree seedlings.

37. The effects of different combinations of commercial fertilizers upon different vareties of tomatoes.

38. Testing varieties of vegetable seeds sent by the U. S. Department of Agriculture, to ascertain their adaptability to this climate.

39. Varietal tests of small fruits.

40. Varietal tests of orchard fruits.

41. Sub vs. surface irrigation in forcing vegetables.

42. Effect of different combinations of fertilizers on forcing vegetables.

43. Field experiments on the influence of fertilizers on tomatoes.

44. Laboratory investigations on the composition of greenhouse tomatoes.

46. Field experiments on the influence of fertilizers on the sugar beet.

47. Field experiments with the sugar beet in different parts of Indiana.

48. The composition of diseased sugar beets.

49. Analyses of marl, peat and muck, "alkali incrustation" of soil, limestone for beet sugar factories, corn cob ash, hominy feed, corn from experiment plats, cow peas and soy beans, ground oat food, oat clippings, distilled dried grains, formaldehyde, butter, milk, casein and albumen in milk.

50. Special water examinations.

51. Special determinations of starch and of carbohydrates extracted by sodium hydrate from feeding stuffs.

52. The digestibility of carbohydrates extracted from hay by sodium hydroxide.

The Station Staff has remained unchanged during the year. Dr. Bitting, as during the year preceding this, has given the Station but half of his time, owing to leave of absence while pursuing medical studies at Indianapolis.

No special improvements have been effected this year. I,

however, desire to most earnestly recommend that a new and suitable sheep building be erected for combined Station and College work. The present building is to say the least a discredit to the institution and to the State, and should be replaced at an early date by something better and adapted to our work. The horticultural department should also be provided with a small shed and tool house in the garden or orchard, in which convenient accommodations may be afforded this department. Thus far, this department has not had any special or independent accommodations, making use of a part of the general tool building, and at considerable inconvenience.

Publications have been issued as follows during the past year:

PAMPHLET BULLETINS.

Bulletin No. 79, June, 1899, pp. 53-62. Roots as food for pigs. By C. S. Plumb and H. E. VanNorman.

Bulletin No. 80, September, 1899, pp. 63-76, figs. 5-12. Sheep scab. By A. W. Bitting.

Bulletin No. 81, December, 1899, pp. 77-92. Field tests with fertilizers on heavy clay land. By H. A. Huston.

Bulletin No. 82, March, 1900, pp. 93-105. Roots and other succulent food for swine. By C. S. Plumb.

NEWSPAPER BULLETINS.

No. 77, July 27, 1899. Milk dilution separators. By C. S. Plumb, Director.

No. 78, August 28, 1899. Causes for inferior quality of muskmelons, and remedy. By James Troop, Horticulturist.

No. 79, September 29, 1899. The use of so-called serum as a hog cholera remedy. By A. W. Bitting, Veterinarian.

No. 80, October 14, 1899. Asparagus rust: A serious menace to asparagus culture. By William Stuart, Assistant Botanist.

No. 81, March 21, 1900. The distribution of seeds by the Indiana Experiment Station. By C. S. Plumb, Director.

No. 82, March 24, 1900. Awnless brone grass (Bromus inermis.) By W. C. Latta, Agriculturist.

No. 83, April 14, 1900. The so-called new treatment for hog cholera. By C. S. Plumb, Director.

No. 84, May 14, 1900. The soy bean. By W. C. Latta, Agriculturist.

No. 85, June 14, 1900. The summer care of milk and cream. By H. E. VanNorman, Dairy Assistant.

ANNUAL REPORT.

Twelfth Annual Report of the Indiana Agricultural Experiment Station, LaFayette, Indiana, for the year ending June 30, 1900, pp. 150, plates XIII, fig. 1.

In addition to the above, members of the Station Staff have published many miscellaneous articles in the agricultural press, or have presented addresses before associations identified with agriculture in some special field.

MAILING LIST.

The Station mailing list has now reached such dimensions, that it will be desirable and necessary to revise it all through during next year. On July 1, this list exceeded over 17,000 names, to many of which our publications have been sent for years with no acknowledgment from the recipients. Undoubtedly many bulletins are being thrown away by being mailed to addresses of person deceased or removal from the post-office addresses to which bulletins are sent. The following table shows the growth of our mailing list for eight years.

TABLE I.

Station Mailing List.

Number names on list.	Jan. 18, 1893.	Jan 4, 1894.	Jan. 10, 1895.	Jan. 1, 1896.	Jan. 1, 1897.	Jan. 1, 1898.	June 30 1899.	Aug. 1, 1900
People in Indiana....	5,741	7,131	8,666	9,143	10,590	11,900	13,458	14,308
Indiana periodicals..	635	668	653	625	660	650	636	636
People in other states	1,158	1,316	1,606	1,788	1,872	2,000	2,200	2,303
Periodicals in other states..............	83	91	86	92	76	80	96	100
Foreigners...........	26	51	61	77	91	105	112	98
Foreign periodicals..	7	7	7	6	8	8	10	7
Total..............	7,650	9,264	11,079	11,731	13,297	14,750	16 512	17,452

The work of the Station is progressing smoothly, and during the year to come more experiments will be reported on in bulletin form than has usually been the case.

This report contains numerous communications on experimental work conducted by the writers. I recommend that 2,500 copies of this report be printed.

Respectfully submitted,

C. S. PLUMB, Director.

THE ASPARAGUS RUST.

By J. C. Arthur.

The first knowledge of the appearance of rust upon asparagus in Indiana came to the Station through Mr. L. C. Breyfogle of Crown Point, Lake County, who sent, October 2, 1899, a specimen of asparagus thickly covered with rust, with the statement that his whole field of seven acres was in the same condition. Shortly afterward a newspaper bulletin[1] was issued from the department calling attention to the invasion of the rust and some means of guarding against it. Up to June of the present year (1900) no other locality in the State was known to be invaded by the rust, although there is reason to believe that since that date it has spread extensively.

The asparagus rust was first recorded for this country by Professor B. D. Halsted[2], who became aware of its presence in New Jersey in August, 1896. It was soon after found in Massachusetts by Dr. G. E. Stone[3], and was probably already well distributed along the coast region from Delaware to Massachusetts, judging by subsequent investigations. On Cape Cod it appears to have existed for a year or two prior to this date[4], but the exact place and means of its introduction to this country are wholly unknown.

The asparagus rust is one of several kinds of rusts that have recently invaded North America from Europe and that have proved disturbing and often seriously harmful factors for the cultivator to contend with. The carnation rust, the hollyhock rust and the chrysanthemum rust are prominent among these, having received much attention from both botanists and cultivators. The asparagus rust is likely soon to force attention from every one who grows this crop, on account of its conspicuously harmful effects, although like other rust diseases, it will doubtless fail to appear some seasons, or at least remain inconspicuous. But no

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[1] Stuart, William—Asparagus rust, a serious menace to asparagus culture. Newspaper Bull. Ind. Exper. Sta. No. 80. Oct. 14, 1899.

[2] An outbreak of the asparagus rust. Issued as a circular from the N. J. Exper. Station. September 18, 1896.

[3] Ninth Rep. Hatch Exper. Sta. for 1896 : 72.

[4] Stone and Smith. The asparagus rust in Massachusetts. Bull. Hatch Exper. Sta. No. 61 : 5.

hope can be held out that it will ever cease hereafter to be troublesome in this country, or that it can be stamped out from even a limited region. The only outlook for the cultivator is to learn how it can be controlled and rendered the least injurious; there is no prospect of banishing it.

When asparagus is attacked by rust (*Puccinia Asparagi DC.*) it shows numerous spots along the stems, both main stems and the smaller branches, and the plants ripen prematurely, turning yellow and often becoming dry and dead many weeks before the usual time. These spots are oval or elongated, just large enough to be seen clearly without aid of a magnifying glass. They start like a blister, but soon burst open and expose a brown or a black powder. The brown powder, which consists of uredospores or summer spores, so called because serving to spread the rust during the warm months from July on, dusts out easily, and rubs off readily on the fingers. The looseness of this powder permits it to be carried away in abundance by the winds and scattered over other asparagus plants near and far, where the disease is started afresh by growth of the spores forming the powder. The black powder does not fall out or rub off readily, being formed later than the other kind, and is made up of spores intended only to grow after passing the winter and when the warmth of another growing season has arrived. It is formed of teleutospores, or so-called winter spores, which are incapable of growth until after a prolonged period of rest.

Beside these two kinds of spores, which are not always told apart with certainty except by help of a microscope, there is another kind, the aecidiospores, or so-called spring spores. These are quite unlike the other two kinds, being bright yellow and formed in minute whitish cups just large enough to be seen by the unaided eye, and usually appearing in groups. This form of the rust is frequently called the cluster-cup stage. It appears from May to July. So far, this stage seems to be rarely produced in this country, and were it not that it has an important relation to the vigor and therefore the harmfulness of the rust it might be ignored. The fewer cluster-cups produced, the less will be the intensity of the disease that season, compared to what it would have been had more cluster-cups been formed. This does not mean, of course, that the fewer the cluster-cups the less rust, because the amount of rust depends upon the summer spores and a state of the weather encouraging their spread and growth, but it means that whatever the amount of rust it will be

deprived of some of its power of injury the fewer cluster-cups that precede.

There are three direct ways of combatting the asparagus rust: (1) destroy the spring spores, which can be done best by hand-picking, as they are usually few; (2) spray frequently with fungicide for a month or two, beginning when cutting stops, in order to prevent both spring and summer spores carried through the air from growing on the surface of the plants to start the disease, and (3) destroy the winter spores by burning over the ground in autumn, or by some other means, thus preventing germination the next spring.

The first of these methods needs no explanation, except to suggest that the careful cultivator will take considerable pains to keep a close watch for cluster-cups and see that they are destroyed, which means annihilated by burning, not thrown on the ground to wither.

The second method has been tried by the New Jersey and New York Stations and so far without large success. Their experiments show that the standard Bordeaux mixture is somewhat too strong for asparagus, making it better to use a weaker solution, and that owing to the difficulty of making the solution adhere some resin should be added to it.

When the sprayings are done at short intervals, about a week or less, so that the rapidly growing roots do not become infected between sprayings, a considerable reduction of the rust has been obtained, but whether this will warrant the commercial application of the method is not yet fully determined.

The third method is readily applied in the main, although to be certain of destroying all the winter spores in a field presents difficulties. If the dead tops are gathered into piles and burned, many spores are destroyed, but also many of the smaller branches well covered with rust will be scattered over the ground and escape. On the other hand, the whole field may be burned over without cutting. There is danger in this method that the tops will not be thick enough in places, or the heat intense enough to burn all the rusted material, especially when some of the tops are still green. To obviate this difficulty straw may be distributed over the field in quantity to insure thorough action of the flames. The burning should be done late in the season, after growth has ceased, for not only will there be more difficulty earlier in making all the material burn, but checking the fall ripening of the underground buds will weaken the next season's growth and conse-

quently cause a greater number of small shoots to start. Stirring the surface soil in fall after burning or as early in the spring as possible, so as to bury, however slightly, the bits of rusted debris will be an additional safeguard. The free use of lime or salt on the field will also tend to prevent the germination of the spores.

There are indirect methods that may be used effectively against the rust. It has been observed by Professor Halsted[5] of the New Jersey Station that in their grounds two varieties were much less affected by rust than the others, eight varieties in all being tested. The Palmetto had scarcely more than half as much rust as the others, excepting a French variety, the Giant Argenteuil, not yet much grown, which had only a third as much rust. The last, however, was not in fair growth for the test, as it was from seed, and seedlings are generally less susceptible than older plants of the same variety. The selection of rust resisting varieties may possibly prove a feasible method of reducing loss from this disease, although it cannot yet be asserted with much confidence.

Another indirect method is to select soil that will supply abundance of moisture during mid-summer, or when possible arrange to irrigate during the dry part of the season. This suggestion is based upon the observation of Dr. Stone[6] of the Massachusetts Station, who found that the injury from rust was far greater in fields with light porous soil incapable of retaining soil moisture during dry periods. The reason for this lies partly in the fact that the rust breaks open the surface tissues of the asparagus plants and thus allows the moisture from the inside of the plants to escape readily, in the same manner as puncturing the surface with needles would do. The plant is thus deprived of moisture faster than the roots can supply it from a deficient soil, and the plants are unable to make suitable growth. It is also claimed that plants making continuously vigorous growth are less attacked by rust than those permitted to be checked through lack of moisture for the roots. Altogether the evidence points to a decided advantage in lessening the injury from rust by providing the conditions that ensure a strong and continuous growth of the plants.

Another indirect method of controlling the rust is to take pains

[5] Twentieth Rep. N. J. Exper. Sta. for 1899 : 411.

[6] The relationship existing between the asparagus rust and the physical properties of the soil. Twelfth Rep. Hatch Exper. Sta. for 1899 : 61-73.

to remove all scattered plants of asparagus growing in hedge-rows, fields or elsewhere in the vicinity. If this is not done, they become centers for the distribution of rust spores and the propagation of the disease. The distance which spores may be carried by the wind is undoubtedly very considerable and careful attention to a field may be rendered quite ineffective by infection from stray plants.

A natural check to the rust occurs in fungous parasites that grow and feed upon the spores. There are two of these known, one of which (*Darluca filum Cast*) has been observed in Indiana. There is no method known, however, by which it can be propagated or fostered.

SUMMARY.

Asparagus rust, first certainly noticed in this country in 1896, has appeared in Indiana.

The rust promises to do considerable injury to the asparagus crop, at least during some seasons.

The rust has three kinds of spores, the spring spores, which are rarely formed; the summer spores, which serve to spread the disease rapidly; and the winter spores, which carry the infection over the winter.

Direct methods of controlling the rust are to destroy the spring spores as they appear by hand-picking, spray frequently after spring cutting is finished to prevent spread of the disease, and burning the plants in autumn to destroy the winter spores.

Indirect methods are to select rust-resisting varieties, if such there be, and provide moisture to ensure good growth of plants during dry periods, if this be feasible.

DAMPING OFF OF BEETS IN THE FIELD.

By J. C. Arthur.

A case of damping off in field culture of beets came to the notice of the Department in May, 1900, and appears to be the first instance of the kind on record. The trouble occurred in the northern part of the State on the farm of Mr. E. T. Mudge, of Medaryville, destroying the larger part of the beets in a field of fifty acres. Samples of healthy and diseased beets, and of the soil in which they grew, were sent to this Station, providing ample material for study.

The beets at the time of the attack were in the first to third leaf following the seed leaves, having been planted about three weeks, and therefore still small seedlings. The roots and stem below ground became black and lifeless, especially the part just beneath the soil, and the top, deprived of nutriment, dropped over on the ground and withered. There was no indication of insect work of any kind. An examination of the roots with a microscope revealed the constant presence of fungous mycelium in the softer tissues. The fungus was composed of colorless branching threads of quite uniform size, winding about between the cells of the cortical part of the root. Comparing the fungus and the behavior of the diseased plants with what is known regarding damping off, as seen commonly in greenhouses, there appears to be no doubt that here was a case of this sort of disease appearing in field culture.

Damping off is due to attack from any one of a number of species of fungi. Attempts were made to induce the fungus in the beet seedlings to fruit by putting into moist chambers, but without avail. In the absence of fruiting parts, it is impossible to name the fungus or even to intelligently guess at its identity. All that can be said is that owing to the attack of some fungus, capable of penetrating the live tissues of the beet seedlings, the young plants were killed.

The conditions under which damping off fungi flourish in the greenhouse are moisture, warmth, and a closeness of the plants that enables the fungus to readily extend from one plant to the next through the damp soil. These conditions are most often met in the cutting bench. If the soil contains decaying vegetable matter, thus furnishing nutriment for the fungous filaments as they extend out from the infested plant, there is a correspondingly greater luxuriance in the development.

All these conditions appear to have been fulfilled in the field of diseased beets at Medaryville. The soil was a black, sandy loam; the seedling beets were close enough together in the row to enable the fungus to pass from one plant to the next from end to end of the field; and the warm, damp days in May furnished most favorable atmospheric conditions; and lastly the earth was of that peculiar richness and texture well fitted to promote saprophytic growth. There is a high probability therefore, that the fungus, very likely starting from many centers, spread along the rows throughout the field, missing, of course, some drier spots and isolated plants, and by its vigorous growth brought about wholesale damping off.

The fungus originated, probably, not from the soil, but from the seed used for planting. The rough, spongy husk of beet seed provides a good harborage for fungus spores, but this growth usually does no harm to the seedling beets from absence of favoring conditions. Although some sorts of spores are present in about all beet seed, yet it may be doubted if those of the particular kind capable of causing damping off are always, or even usually, present.

I am informed by Mr. Charles K. Farmer, field superintendent of the Wolverine Sugar Company, that a disease very similar to this one, affected young sugar beets in Michigan during the spring of 1899. It passed under the name of "Black root," and differed from the Indiana outbreak chiefly in its failure to kill the plants outright. The surface tissues of the roots blackened, but the central axis remained alive, and in fields that were not plowed up, the plants largely recovered. No microscopical examination was made.

A remedy for the disease, after it has once started in a field, seems out of the question. Sometimes, however, weather or other conditions check its spread. It would probably be possible to sterilize the beet seed used for planting. Either formalin or hot water could doubtless be used to destroy the fungous spores without impairing the vitality of the seed, and possibly with direct beneficial effects in promoting germination. Details for treatment cannot be given, as no experiments have been made. If this method of ridding the seed of the germs of disease proves available, it might be profitable to treat all beet seed before planting, but especially that to be used in fields having certain rich, light soils.

FORMALIN AND HOT WATER AS PREVENTIVES OF LOOSE SMUT OF WHEAT.

By J. C. Arthur.

The loose smut of wheat is a prevalent source of loss to the farmer. There is a saying that "the more smut, the better the crop," which is a fallacious and misleading observation, based no doubt on the fact that conditions which promote the development of the smut parasite, and therefore in seasons giving a heavy growth of wheat, the smut is likely to be unusually conspicuous. Under such conditions it is not rare for the loss due to smut to be as high as 25 to 50 per cent. of the crop. In spite of this loss the yield of grain may be good, but it would have been just so much the better, if the smut could have been prevented. The prevalence of loose smut in wheat varies greatly from year to year, but very often amounts to 10 per cent. of the crop. The loss is almost certain to be considerably greater than casual observation seems to suggest, on account of the inconspicuousness of wheat heads attacked by it.

In the earlier bulletins[7] on grain smuts issued by this Station, it was recognized that loose smut was more difficult to eradicate from wheat than the stinking smut, but in the absence of definite knowledge the assumption was made that the fungicides used against stinking smut would also serve against loose smut, if carefully applied.

In 1891, Messrs. Kellerman and Swingle[8] made extensive trial of fungicides for loose smut, 54 lots being treated, but without decisive results. The amount of smut in the control lots was, however, small, which added to the uncertainty of the test. Their conclusion was that "no grounds based on actual experiment appear to exist for recommending the treatment of the seed with hot water or any other fungicide." A careful review of their data seems to me to show that some forms of their treatment did reduce the amount of smut, but that none showed indications of proving efficient in removing all smut.

The same year this Station also made experiments with loose smut, and the results are here published for the first time. The

[7] Arthur, Smut of wheat and oats, Bull. Ind. Exper. Sta. No. 28, September, 1889; and Treatment for smut in wheat, same, No. 32, July, 1890.

[8] Bull. Kans. Exper. Sta. No. 22.

seed grain used for the test was saved from crops grown on the Station grounds during 1890. Two varieties were employed, the Original Red and the Ontario Wonder. A careful estimate made in the field by counting two or three thousand stalks[9] gave nearly 12 per cent. of smut for the former and over 24 per cent. for the latter, so that the seed available for the test was sufficiently contaminated with smut to ensure marked results.

The seed was treated by immersing five minutes in water at a temperature of 135 Fahrenheit. It was sown October 22, 1891, the day after treatment, each variety occupying two drills, 66 feet long, with an equal area sown with untreated seed as a control. The wheat of all four lots grew well, passed the winter without injury, and gave a good yield. The amount of smut was estimated the middle of June, 1892, with the result that no perceptible influence of the treatment could be detected. The data are given in table II.

TABLE II.

Hot water treatment for loose smut of wheat in 1891-2.

Variety of wheat.	Number of stalks counted.		Per cent. of smut.	
	Untreated.	Hot water 135° for five minutes	Untreated.	Hot water 135° for five minutes.
Original Red..........	3127	3316	6.	5.6
Ontario Wonder.......	2759	2679	15.75	15.85

The amount of smut showing in the resulting crop, although nowhere near so much as in the previous crop from which the seed was taken, was still sufficiently high to make conspicuous any variation that might be traceable to the treatment. That the two varieties of wheat showed correspondingly less smut in 1891 than in 1890, may have been due to several causes, but judging from a number of incidental observations in connection with other experiments as well as this it was probably due largely to the extra manipulation the seed received in cleaning and treatment, which separated the spores to a greater extent than in the usual handling.

A much more elaborate set of experiments was tried in 1898-9 with the aid of the assistant botanist, Mr. William Stuart, in

[9] For exact data see Bull. Ind. Exper. Sta. No. 32, p. 9.

which both hot water and formalin were used. As formalin had been found efficacious against stinking smut of wheat, it seemed highly probably that a right adjustment of strength and length of trèatment would show that it could also be used for loose smut, while it was by no means certain that hot water by some method of application would not yet prove serviceable. The two methods were also combined, the solution of formalin being used both hot and cold. The treatment was made especially severe in order to kill the smut spores if possible, though part of the seed might in consequence also be killed. Formalin (40 per cent. formaldehyde) was used in two strengths, one pound of formalin (9.072 gr., 8.2 cc.) to 50 gallons of water, and one to 25 gallons. Less than a pound of seed was treated in each lot.

In order to be more certain of the exact effect of the treatment upon the vitality of the seed, a laboratory test for germination was made, using 200 seeds of each lot placed in a Geneva germinator. It showed that much of the seed was injured, the degree of injury corresponding very well to that shown by vegetation in the open field, but less pronounced. In the field some of the lots not only came up poorly, but grew feebly, and were much injured during the winter. Further data are given in table III.

TABLE III.

Laboratory and field observations on vitality of seed, 1898-9, treatment being in small lots.

TREATMENT.	Percent germination in the laboratory.	Field observation.
Untreated	97	good
Formalin, 2 hrs., strength 1-50, at about 73°	96	good
Formalin, 2 hrs., strength 1-25, at about 73°	90	medium
Formalin, 14 hrs., strength 1-25, at about 73°	42	poor
Formalin, 10 min., strength 1-25, at 135°	34	very poor
Hot water, at 132°, Swingle method*	84	medium
Hot water, 10 min., at 135°	63	poor

*The method designated here as the Swingle method is given in Farmers' Bulletin No. 75 of the U. S. Department of Agriculture, written by Mr. Walter T. Swingle, and consists in soaking the seed four hours in cold water, permitting it to drain four hours, then plunging several times into water at 110° to 120°, and finally immersing five minutes in water at 132° to 133°.

The seed was sown September 26, one week after being treated, by means of a hand drill. One strip of six rows was sown for

each kind of treatment and two strips with untreated seed for controls. The growth was not as vigorous as usual, even from the untreated seed, and the winter weather also proved unfavorable to wheat, so that the stand of wheat in the spring was not good, and on some of the treated areas scarcely a plant remained. Moreover, the amount of loose smut showing in the untreated part of the crop was very small, as it had not been possible to secure seed from heavily smutted fields, as in the earlier experiments. Such results as were obtainable are given in table IV, and they cannot be said to do more than indicate a bare possi-

TABLE IV.

Results of treatment of small lots of wheat for loose smut, 1898-9.

TREATMENT.	Number stalks counted.	Percent of smut.
Untreated	2169	.46
Formalin, 2 hrs., strength 1-50, at about 75°	1140	0
Formalin, 2 hrs., strength 1-25, at about 75°	1057	0
Formalin, 14 hrs., strength 1-25, at about 75°	Too few	....
Formalin, 10 min., strength 1-25, at 135°	to estimate	....
Hot water, at 132°, Swingle method	1421	0
Hot water, 10 min., at 135°	571	.53

bility of finding a successful method of treatment. No smut is recorded for any of the treated lots, except that with hot water for 10 minutes, which showed even more smut than the untreated lot. As this particular treatment was sufficiently severe to kill one-third of the seed, while it does not appear to have killed the smut spores, doubt is thrown upon the efficiency of the hot water treatment, unless it be assumed that a slower method of application be required, like that recommended by Swingle, which seemed to have killed all smut spores provided any were present, with even less injury to the seed. The four methods of using formalin appear to have been effective, and with two hours immersion at a strength of one pound to 50 gallons of water almost no injury resulted to the germinating qualities of the seed. Altogether, however, the test proved in many ways unsatisfactory and inconclusive.

Another test was made at about the same time, using larger quantities of seed and varying the form of treatment in accordance with information secured from the laboratory study of germination in the last trial as recorded in table II. It was made

a test of formalin, used both hot and cold, with a number of variations in the method of application. Two lots of seed were used; one lot being Michigan Amber, grown upon the Station grounds, and the other an unknown variety grown by a neighboring farmer. In neither instance was the amount of smut especially marked in the field. About 8¾ pounds (4 kilograms) of seed were treated at a time.

With the Michigan Amber wheat a rather strong solution of formalin (one pound of formalin to 25 gallons of water) was used, and the time of immersion reduced to one-half an hour, and the application made both hot and cold. The temperature for the hot solution was 136° when the seed was put in, and this was allowed to drop without hindrance. Immersing the seed caused the temperature to drop at once to 126°, 10 minutes later it was 118°, after 22½ minutes it was 113½°, and at the end of the half hour 113°. Two forms of control were also given a half hour soaking in water. The latter was done to offset the soaking required in using formalin, and was expected to show if the wash-

TABLE V.

Treatment of large lots of wheat for loose smut. 1898-9.

Kind of wheat.	TREATMENT.	Percent germination in the laboratory	Percent smut in crop.
Michigan amber.	Untreated	99	1.78
	Cold water, ½ hr., at 71°	98	1.21
	Formalin, ½ hr., strength 1-25, at 75°	88	1.00
	Formalin, ½ hr., strength 1-25, at 136° falling to 113°	74	1.10
Unknown variety.	Untreated	96	.63
	Formalin, 2 hrs., strength 1-50, at about 75°	90	.13
	Formalin, 2 hrs., strength 1-50, at 127°, falling to 101°	67	.26

ing and swelling of the seed had any effect in itself upon either the growth of the seed or the action of the smut.

For the other variety of wheat the formalin solution was made twice as weak (one pound of formalin to 50 gallons of water), the time of immersion extended to two hours, and the application made as in the former case both cold and hot. For the hot solu-

tion the temperature dropped when the seed was immersed from 127 to 122°, in 55 minutes it stood at 108½°, and in an hour and a quarter at 105°, in an hour and three-quarters at 101½°, and at the end of the two hours at 101°. Only the customary untreated control was used.

After treatment 200 seeds of each lot were placed in a Geneva germinator. The result, see table V, showed that the formalin treatment in each case injured the germinating qualities of the seed more or less, especially when the hot solutions were used. The seed was sown September 29, three days after treatment, with a two-horse drill set to sow five pecks per acre. The vegetation, as seen five days afterwards, the weather having been especially favorable, was good except where the seed had been treated to hot solutions of formalin, these being only fair. A good fall growth was made, but the winter proved unusually severe, and all of the plats suffered, especially along the south halves, where the soil was less favorable to a vigorous growth, but plats having formalin treatment showed the greatest injury. When the wheat began to ripen by the middle of June the treated plats still showed a difference by being somewhat behind the others. The smut was estimated on June 13, by counting one to two thousand stalks in each plat, the data being given in table V.

About three times as much smut developed in the Michigan Amber as in the other variety, giving figures sufficiently large to establish considerable confidence in the results. What strikes one as especially noticeable is the failure of the formalin, however applied, to eradicate the smut, even where the treatment was severe enough to kill nearly a third of the seed. It is apparent however, that the treatment did reduce the smut, amounting to about 63 per cent. in the extreme case, but that this reduction was to any considerable degree due to the fungicidal action of the formalin or hot water may be doubted. It is to be observed in the first place that the same strength of formalin applied cold gave better results in both instances than when applied hot, and yet it is a well established fact that water at the high temperature here used has no mean fungicidal value. It is also to be observed that seed simply soaked in cold water gave a reduction of 32 per cent. of smut over that unsoaked, and certainly no fungicidal action can be ascribed to cold water.

It is the belief of the writer that this reduction of smut is not due materially to any destruction of the smut spores by the treatment, but chiefly or wholly to the incidental removal of the spores

by the additional manipulation that the treated seed receives. Many of the spores are washed away by the water in which the seeds are immersed, as is readily shown by putting a drop of the solution under the microscope, and many more are removed in the process of drying and other extra handling. It is believed that the reduction of smut obtained by the several forms of treatment may be practically accounted for by assuming that the seed is considerably freed from smut incidentally rather than that the smut is killed by the treatment.

Some attempt was made to ascertain directly what action formalin and hot water had upon the smut spores by treating small quantities of smut after the several methods used for the seed and then testing their viability by placing in a hanging drop in a moist chamber, the examination being made with a microscope. Loose smut gathered the middle of June showed abundant germination. For want of time no further examination was made for three weeks, when it was found that the spores which had in the meantime lain in the laboratory would not germinate readily. Smut brought directly from the field during the second week of July showed but moderate germination. Several forms of treatment were attempted, but owing to the indifferent growth of the control sets, the results are not considered reliable and are omitted. The loss of viability by moderate desiccation is an unexpected phase of the problem, for which no explanation can at present be offered. There is evidently need of a more critical examination into the life history of the smut fungus, in order that we may know how surely proposed remedial treatment is directed against the vulnerable part of its cycle.

Practical Deductions.

A study of the above data leads to a pretty definite conclusion that the loose smut of wheat cannot be removed from a crop by treatment of the seed with formalin or hot water, not even when the treatment is so severe as to kill a third or more of the seed. The statement made by the writer in an earlier bulletin of this Station (No. 77, p. 39) still holds good, even after making studies that were expected to overthrow it, that "at present there is no satisfactory remedy or preventive to be recommended for this kind of smut."

There are indirect methods for getting rid of loose smut in wheat, however, that are clearly worthy of attention. That rec-

ommended by my colleague, Professor Latta[10], should be used when feasible. He advises selection of seed from fields known to be free from smut and sowing on land that has not borne wheat for two or three years. In this connection let it be remembered that the loose smut of oats is wholly distinct from that of wheat, and no transfer of one to the other can take place, so that wheat may follow oats as safely as to follow potatoes or corn. Professor Latta also says that "in all cases it is desirable to thoroughly screen wheat for seed, using a strong blast which will dislodge and blow out at least a portion of the smut germs." This last suggestion seems to me, in view of the facts here recorded, to be worthy of special emphasis. A good use of the fanning mill will certainly lessen the smut in the crop, if any spores are present, and will also remove seeds of noxious weeds and the inferior part of the grain, altogether greatly raising the standard of purity and quality.

[10] Bull. Ind. Exper. Sta. No. 45, p. 61. 1893.

FORMALIN AS A PREVENTIVE OF MILLET SMUT.

By William Stuart.

In the spring of 1899, some seed which had been obtained from a badly smutted field of millet, was treated with formalin for the prevention of smut. It was divided into five lots, each of which received different treatment. The treatment given each lot was as follows:—

Lot I. Soaked one hour in a solution of formalin at the rate of one pound formalin to sixty gallons water, a 1 to 60 gallon solution.

Lot II. Soaked two hours, in a solution of the same strength as I, a 1 to 60 gallon solution.

Lot III. Soaked one hour in a solution of formalin at the rate of one pound formalin to 45 gallons of water, a 1 to 45 gallon solution.

Lot IV. Soaked two hours in the same solution as Lot III, 1 to 45.

Lot V. Soaked one hour in cold water.

The seed was planted June 5 and made a good growth during the season. On August 9, when well headed out, the per cent. of smut in each plat was estimated by counting a large number of heads. The results of this count which are given below, shows that the smut was entirely prevented in lots III and IV, which had been soaked in the stronger solution of formalin.

Lot I, treated 1 hour in a 1:60 solution, contained .08% smut.
Lot II, treated 2 hours in a 1:60 solution, contained .86% smut.
Lot III, treated 1 hour in a 1:45 solution, contained no smut.
Lot IV, treated 2 hours in a 1:45 solution, contained no smut.
Lot V, soaked 1 hour in cold water, contained 2.86% smut.

Those of I and II, while not entirely free from smut, showed a very appreciable decrease from the untreated lot, V, which contained nearly three per cent. The discrepancy between I and II, the former having only .08 per cent. of smut, while the latter contained .86 per cent., is probably a purely accidental feature.

The results of the experiment as a whole point conclusively to the efficiency of formalin as a preventive of millet smut. Seed soaked either one or two hours in a formalin solution at the rate of one pound formalin to forty-five gallons of water, should effectively rid the resultant crop of smut.

A STUDY OF THE CONSTITUENTS OF CORN SMUT.

By William Stuart.

In preparing the material for the article upon corn smut, published in the last annual report[11], several topics then under observation were necessarily left incomplete. Some of the more interesting results of these studies are given here, as in a measure supplemental to the publication of last year. The work has been performed under the direction of Dr. J. C. Arthur.

Tests for Alkaloidal Salts. This work was carried out by the writer, with much valuable assistance and oversight, especially at the first, from Prof. J. W. Sturmer of the Purdue School of Pharmacy. The methods employed in this investigation were to make an extract of the smut spores and such detritus as would pass through a fine seive, and then by the use of standard alkaloid reagents to note whether precipitates were formed or not. Only qualitative tests were made.

In one case one hundred grams of the seived smut spores were taken and after thoroughly moistening them in a dish by adding 33 1-3 per cent. alcohol and stirring together, the whole mass was again passed through a seive to break up lumps and transferred to a percolator previously fitted up for the purpose. The mass of spores were pressed down firmly, then covered with a filter paper so molded as to cover the surface of the spores and to extend up the sides of the percolator about three-quarters of an inch. A few pieces of glass rod laid upon the filter paper sufficed to keep it in place. Sufficient alcohol of one-third strength was then added to the percolator to cover the spore mass to a depth of about one-half inch. The top of the percolator was covered with a petri dish to prevent the evaporation of the alcoholic solution. As the alcholic solution was absorbed by the corn smut spores additional liquid was added. Maceration of the smut spores was continued for twenty-four hours before any of the liquid was allowed to percolate through into the receiver, percolation being prevented by adjusting the receiving flask above the level of the material in the percolator. After twenty-four hours maceration in the alcohol, the receiving flask was lowered and adjusted so as to permit of about two drops passing over into the flask per minute. Percolation was continued until the

[11] Arthur and Stuart, Twelfth An. Rep. Ind. Exper. Sta. 84-135.

percolate was colorless, usually from two to three days, sufficient alcohol being added to keep the surface of the spores covered. The first 50 c.c. of the percolate was set aside and the balance collected and evaporated down to 50 c.c. on a steam bath. This was added to the first amount saved, making 100 c.c. of the extract, each c.c. of the extract representing one grain of the spores.

To test the extract for alkaloids, a certain amount of it was taken and evaporated to dryness on a steam bath. The residue was treated with a five per cent. solution of sulphuric acid and filtered. The filtrate was then subjected to tests with the following reagents:

1. Potassium mercuric iodide (Mayer's solution).
2. Phosphotungstic acid.
3. Iodine in potassium iodide solution.
4. Picric acid.

A small quantity of the filtrate was poured into four watch-glass crystals and then a drop or two of the reagent used. If no precipitate was formed, a few more drops of the reagent were added. The reactions obtained by this method were as follows:

Reagent 1. A slight milky turbidity was produced.

Reagent 2. A decided milky turbidity was produced.

Reagent 3. No visible reaction could be noted.

Reagent 4. No visible reaction could be noted.

A number of tests with the same and with fresh lots of extract prepared in the same manner gave similar results.

Test for total alkaloid, (short method). The second method employed for extracting corn smut fluid was that of using a modified "Prollius' Fluid."[12].

To 50 c.c. of Prollius' fluid in a conical flask was added two grams of corn smut; the flask was stoppered securely with a cork made impervious to ether and vigorously shaken at intervals. After macerating four hours the supernatant solution was drawn off and filtered. The filtrate was evaporated to dryness on a steam bath and the residue treated with a five per cent. sulphuric acid solution. The acid solution was filtered and the filtrate

[12] Modified Prollius' fluid.

Ether	250 c.c.
Chloroform	100 c.c.
Alcohol	25 c.c.
28% ammonia	10 c.c.

tested with the reagents as mentioned for the alcoholic solution. The reactions obtained were as follows:

Reagent 1. A slight turbidity was produced.

Reagent 2. A marked milky turbidity was produced.

Reagent 3. No reaction could be observed.

Reagent 4. No reaction could be observed.

Test for total alkaloid, (general method). The method employed in this test was that outlined by Messrs. J. W. Sturmer and C. E. Vanderkleed[13], called "Process one"

General.—"For total alkaloid." The process was to take ten grams of the corn smut and after transferring it to a 150 c.c. conical flask ,100 c.c. of "Modified Prollius' Fluid" was added to it. The flask was stoppered securely with a cork made impervious to ether. The smut spores were allowed to macerate in the fluid for twenty-four hours, shaking the flask vigorously at intervals. The next step, called the "shaking out process," was to pipette off 50 c.c. of the clear supernatant solution; this was passed through a filter into a 250 c.c. separatory funnel. The filter and funnel were washed with 5 c.c. of ether which was allowed to enter the separatory funnel. The solution was acidified with equal parts of three per cent. sulphuric acid and water. By a rotary motion of the globular separatory funnel the aqueous portion of the solution was separated from the immiscible portions of the fluid. The aqueous or lower layer was then drawn off. The shaking out process was twice repeated, using very dilute sulphuric acid, one part of three per cent. acid to nine parts of water for the first washing and 10 c.c. of water for the second. The several washings were collected in the same flask with the acid liquid first drawn off. The abstraction of the alkaloid was then considered practically completed.

To remove certain plant principles other than alkaloids which may have passed into the acid water, owing either to their solubility in water or to the fact that some etherial liquid dissolves in water, the acid water solution was again returned to the separatory funnel, which in the meantime had been thoroughly cleansed and 10 c.c of chloroform added. By rotating the funnel the chloroform, or lower layer, was soon separated from the aqueous

[13] W. J. Sturmer and C. E. Vanderkleed. "Elementary Course in Quantitative Chemical Analysis." Compiled for students of Purdue School of Pharmacy. :61-64, 1898.

solution and was drawn off and discarded. To remove the ammonium sulfate formed on acidifying the solution it was again treated to 10 c.c. of chloroform and then enough 10 per cent. ammonia water was added to render the mixture slightly alkaline. The separator was again rotated for some time, after which the chloroformic layer was drawn off. The alkaloids are dissolved by the chloroform while the ammonium sulfate being insoluble in chloroform will remain in the aqueous layer. This washing with chloroform was twice repeated, each time using 10 c.c. of the chloroform. The successive washings being collected and added to that of the first in the flask, if it is desired to recover the chloroform, or if not, in an evaporating dish. The latter method was followed, the solution being evaporated to dryness over a steam bath. The residue was treated with a 3 per cent. solution of sulphuric acid; this was filtered and the filtrate tested for alkaloids, as in the first two processes mentioned. The reactions obtained were as follows:—

Reagent 1. A slight turbidity was obtained, which on standing for some time, deposited a dark brownish substance on the bottom of the glass.

Reagent 2. A marked cloudiness was obtained, which on standing for some time deposited a whitish crystalline precipitate on the bottom of the glass.

Reagent 3. No visible reaction, or any deposit after standing.

Reagent 4. No visible reaction, but on standing a slight deposit was noticed on the glass.

Tests for Alkaloids in Commercial Extract of Ergot and Corn Smut.

The uniformity of the results obtained from the reagents employed, the first two giving positive and the last two negative tests, in each instance, led to an examination of the commercial extracts of both ergot and corn smut.

Ergot of rye test. The commercial fluid extract of ergot was obtained from a leading wholesale druggist in the city, whose supply was obtained from the well known firm of Parke, Davis & Co., of Detroit, Michigan. The fluid extract was evaporated to dryness over a steam bath, the residue treated with dilute sulphuric acid and filtered as in the preceding processes, and tests made with the reagents. The reactions obtained were as follows:—

Reagent 1. A yellowish brown, curdy like precipitate was obtained.

Reagent 2. A cloudy white precipitate was obtained, which on standing deposited a purplish brown curdy like substance.

Reagent 3. A reddish brown precipitate was obtained.

Reagent 4. No reaction was obtained.

Corn smut ergot test. The material used was obtained from the same local druggist, who in turn received his supply from the well known firm of Merrill & Co., Cincinnati, Ohio. The material was treated in the same way as in the preceding test, and the reactions obtained were somewhat similar.

Reagent 1. A precipitate was formed, but it was not so marked as in the ergot of rye.

Reagent 2. Reaction much the same as in that of rye ergot.

Reagent 3. Reaction not quite so marked as in the rye ergot.

Reagent 4. No reaction was obtained.

A brief summary of the work shows that a substance was obtained in all the extracts made which gave positive reactions with the first two reagents used, and negative ones with the last two. Commercial extracts of rye ergot and of corn smut gave similar reactions to those obtained from the corn smut extract prepared in the laboratory in the case of reagents one and two, while they gave marked results in reagent three, from which negative results were obtained in all preceding trials.

Physiological Effect of An Alcoholic Extract Upon Horses.

This portion of the work was carried on in connection with that of the tests for alkaloids. The alcoholic extract was made by the writer in the same manner as described in the preceding pages. The experimental work upon the horses was performed by Dr. R. A. Craig, of the Veterinary Department, who has kindly placed at my disposal the appended notes, upon the amounts and effects of the doses administered.

Horse No. 1. A gelding, poor in flesh, but healthy, was given 15 c.c. of the extract sub-cutaneously. The dose seemed to have no effect. The next day 30 c.c. were given in the same way. In twenty-five minutes he stopped eating. The pulse and breathing were quickened and the peristaltic movement of the in-

testines was increased. Forty-five minutes after the drug was given, faeces were passed. No further effects were noted.

Horse No. 2. A gelding in good condition, was given 25 c.c. of the extract sub-cutaneously. In twenty minutes he became restless, stopped eating and the pulse and breathing were quickened. A moist evacuation of faeces occurred in twenty-five minutes. An hour after giving the injection its effects had passed off. Two days afterward 45 c.c. were given. The horse soon became restless, the intestinal murmurings were loud and an evacuation of faeces soon followed. When made to turn in the stall his movements were slow and unsteady. One hour after giving the injection his pulse was sixty and his respirations forty-three per minute. He refused to eat and remained rather dull till noon the following day. After an interval of a few days the horse was given 130 c.c. per orum. In forty minutes he stopped eating and his pulse and breathing were quickened. Outside of his refusing to eat, no other effects of the drug were noted.

Summary. The sub-cutaneous injection of 25 to 30 c.c. of the drug caused the animal to become restless and increased the peristaltic movements of the intestines. This was followed shortly by evacuation of the contents of the rectum. At the same time the pulse and respiration were quickened. The effects of the dose passed off in an hour.

The injection of 45 c.c. produced in addition to the above symptoms, a dullness and an unsteady gait when made to move. The effects of the dose were much more lasting. The horse remained dull and refused to eat for twenty-four hours.

A 15 c.c. sub-cutaneous injection and a 130 c.c. per orum dose produced but little effect.

While the results of both the chemical and physiological tests of the corn smut are at variance with those obtained by some other investigators[14], they are in accordance with a number of chemists[15], and to some extent in their physiological action to

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[14] Kedzie, Bull. Mich. Ex. Sta. No. 137 : 45. 1896.
Mayo, Bull. Kans. Ex. Sta. No. 58 : 69. 1896.

[15] Dulong, Jour. de Pharm. 14 : 556. 1828.
Cressler, Amer. Jour. Pharm. for 1861 : 306.
Parsons, Rep. Dept. Agric. for 1880 : 136-138. 1881.
Hahn, Amer. Jour. Pharm. 53 : 496. 1881.
Rademaker and Fischer, Med. Herald for 1887 : 775.

that obtained by Dr. Mitchell[16] whose experiments were performed upon the frog. The concordance of the results obtained from both the chemical and physiological tests, would indicate the presence in minute quantity of some narcotic in corn smut. What this narcotic is, and why, when corn smut is consumed in large quantities by farm animals, it does not produce more harmful results, are questions which are yet to be determined.

Moisture and ash determinations. Determinations of the per cent. of moisture and ash contained in the smut spores were made in connection with the alkaloid examinations. The average of several moisture determinations was found to be 8.37 per cent., while that contained in some outdoor spores recently exposed to rains was found to be over 36 per cent. The average amount of ash as obtained from several ash determinations was 5.32 per cent. These results agree quite closely with those of Parsons[17] and Kedzie[18] on the per cent. of moisture, the former obtaining from 9-10 per cent., and the latter 8.30 per cent. In the ash determinations the results agree quite closely with those of Parsons, who found from 4.5 to 5 per cent. of ash.

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[16] Mitchell, Jas. The physiological action of Ustilago maidis on the nervous system. Inaug. Thesis, Univ. Pa. 1883. Therap. Gaz. Detroit, 10 : 223-227. 1886.

[17] Parsons, H. B. Analysis of corn smut (in report of the chemist. Peter Collier) Rep. U. S. Dept. Agr. for 1880 : 136-138. 1882. Also in New Remedies, 11 : 80-12. 1882.

[18] Kedzie, Dr. R. C. In bulletin 137 of the Michigan Agr. Ex. Sta. :45. 1896.

A BACTERIAL DISEASE OF TOMATOES.

By William Stuart.

During the winter of 1898-99, while engaged in an experimental study in the growing of tomatoes by the aid of chemical fertilizers, considerable annoyance was occasioned by the appearance of a disease which attacked the fruit and rendered them unmarketable. The disease was very similar to one noticed by Beach [10], while carrying on some experiments with tomatoes during the winter of 1896-97. Usually the fruit showed no sign of injury until two-thirds grown and sometimes not until fully developed. (See Fig. 1.) The first visible appearance of the disease in infected fruits was in a slight watery discoloration of the tissue beneath the epidermis. As the disease progressed the affected portion assumed a darker color, followed by a gradual depression of the infected tissue, resembling in many respects that caused by the black rot, *Macrosporium solani*, but without any fruiting hyphae growing on the surface of the epidermis. It rarely wholly destroyed the fruit, but as a rule seemed to hasten its maturity. Generally the disease attacked the apical portion of the fruit, in a few instances, however, the central or basal portions would show the characteristic watery discolorations first.

Fig. 1. From photograph showing development of plants when fruit showed first signs of infection.

A miscroscopic examination of diseased portions of the fruit gave

no evidence of the presence of any parasitic fungus. The presence of a minute motile bacillus seemed, however, to be fairly constant in all the tissue examined.

Isolation of the germ. In the isolation of the germ two different methods were employed. In one, sections of the diseased tissue were removed from the fruit with a flamed knife and transferred to agar and bouillon tubes, from which direct inoculation of the tubes were made, from the inner portions of the diseased tissue by means of a sterilized platinum wire.

The cultures obtained from both these methods were apparently similar; both contained a minute motile bacillus having the same appearance as that noted in the microscopical examination. The germ thus obtained was assumed at the time to be the same as that seen in the diseased fruit, but its after behavior did not in all respects bear this out.

Growth of the germ on agar. The growth of the germ upon slightly acid slant agar was quite characteristic; it produced a vigorous growth with irregular outline all along the track of the needle.

The color of the growth upon agar was creamy white on the margins, becoming yellowish towards the center, and having a marked viscid surface.

Bouillon cultures. In bouillon tube cultures the germ made but slight growth.

Pasteur solution. Culture of the germ in the Pasteur sugar solution made a much more marked growth than in the same media without the sugar. No gas was formed in the fermentation tubes, containing the Pasteur sugar solution.

Starch solution. This solution was prepared by supplementing starch for the sugar in the Pasteur sugar solution. Growth in this media was rather slow, and quite unsatisfactory.

Inoculation experiments. On February 15 two tomatoes which had every appearance of being perfectly healthy were removed from the plants to an adjoining room. One of these was inoculated with a pure culture of the germ, by puncturing the epidermis with a sterilized platinum wire and with another transferring the germs from the tube to the interior of the fruit. The remaining fruit was merely infected by smearing the germ over the surface of the pistillate portion of the fruit. After inoculation both fruits were placed under a bell-jar. At the end of the second day the first fruit showed signs of infection; a portion of the cells

[19] Beach, N. Y. Exper. Sta. (Geneva) Bull. 125;305-306. July, 1897.

adjacent to the opening made for the introduction of the germ were fast turning a dark color. In a week the greater portion of the tomato was diseased and was giving off an offensive odor. By March 1, or thirteen days after the time of infection, it was completely decomposed, while the one on which the infection material had been smeared showed no signs of infection.

In comparing the action of the disease upon the artificially inoculated fruit with that of one naturally infected, it will be noted that with the exception of the first appearance of the disease their action is entirely different. In the natural infected fruit there was no offensive odor, it rarely affected the whole fruit and never caused a sloughing of the cell tissues as did the artificial infections. Further inoculations only more fully confirmed these observations. The wide difference in the action of the germ in the natural and artificially infected fruits may indicate that they were not the same, although looking so much alike, or may be explained by supposing that in the naturally infected fruits the epidermis not being broken, excludes all putrefactive bacteria, while in the artificial infections the puncturing of the surface of the fruit to admit the germ, provides the most favorable conditions for the entrance of putrefactive bacteria. The putrefactive bacteria feeding upon dead tissue, find a suitable media in the tissues destroyed by the action of the inoculated germ and thus the two acting in conjunction make the destruction of the fruit much more rapid and complete.

On March 2, two more healthy tomatoes about two-thirds grown, were removed from the vines and after photographing were inoculated as in the first instance, that is, the spores were introduced into the interior of one fruit and smeared over the outer surface of the other. Like those of the first experiment, the one having the infective material smeared on the outside remained sound, while the other soon showed signs of disease. The progress of the disease in the second experiment was, however, somewhat slower than that of the first. Eventually the whole fruits were again photographed. Plate I, Fig. 1, represents them previous to inoculation, while in Plate I, Fig. 2, the changed condition of the diseased fruit is shown.

In order to determine whether the same effects would be obtained by inoculating the fruit on the vine, a cluster of fruit containing four half to two-thirds grown tomatoes, was selected for experimentation. Two of the tomatoes were inoculated by introducing the germ into the tissues of the fruit with a sterilized

needle. In order to note the effect of the injury from needle puncture the third fruit in the cluster was punctured with a sterilized needle while the fourth was reserved for a control. All inoculations were made on the north side of the fruit in order to avoid any action of the sun upon the wound. Three days later the tissues surrounding the infected portions of the first two fruits had begun to grow darker. From this time on the destruction of the tissues was quite rapid. No ill effects could be noted on the fruit punctured with the sterilized needle, both of the latter fruits remaining perfectly sound.

In addition to the above experiments, an attempt was made to infect the fruit in the earlier stages of its development by smearing some of the germs on the pistil of the flower. The results obtained from this line of experimentation were a complete failure, as but one blossom out of the several infected developed a fruit, and this did not grow to any size. It is quite probable that the presence of the infective material upon the stigma was in itself responsible for the non-pollination of the fruit.

Summary.

A decay of green fruits on tomato plants grown in the green house seemed from a microscopical examination to be of bacterial origin. The fruit showed patches that looked watery, became depressed, after a time turned blackish. Usually the disease started at the blossom end, but sometimes at other parts. No evidences of a fungus were present.

Attempts to separate a specific germ were apparently successful. Inoculation of green fruit by puncturing the epidermis and introducing the supposed germ of the disease from pure cultures in every instance produced a disease.

Applying the cultural material to the outer surface of the fruit gave negative results.

The disease induced by the germ from the culture did not correspond in some particulars with that from natural infection, and there is still doubt if the two be the same.

No preventive measures can be suggested with the limited knowledge of the disease yet available.

EPIDEMICS OF HOG CHOLERA AND SWINE PLAGUE.

By A W. Bitting, M. D., D. V. M.

In conducting a study upon the epidemics of hog cholera, the object has been to determine the manner of dissemination of the germs which cause such wide spread epidemics and to determine if possible, how far such means are within our control. Hog cholera and swine plague have been studied from the bacteriological and pathological stand points in many laboratories, and this department has accepted the findings of these investigators, but has made no efforts to verify or to add to them. It has been the effort to see how far the deductions from the laboratory studies can be applied in a practical way in combatting the disease. The observations upon which this paper is based cover a period of eight years from 1893 to 1900, inclusive.

Indiana has produced and lost the following number of hogs during the years given below in table VI:

TABLE VI.

Hog production and loss from disease in Indiana from 1883-1900.

Year.	Produced.	Lost.	Per cent of loss.
1883	3,365,462	288,286	8.6
1884	3,589,821	351,166	9.8
1885	3,306,818	326,555	9.9
1886	3,361,981	402,164	12.
1887	4,313,940	512,692	7.5
1888	4,060,121	326,359	8
1889	3,689,739	372,868	10.
1890	4,333,403	256,991	5.9
1895	2,890,797	278,143	9.3
1896	3,258,580	580,267	14.8
1897	3,638,535	899,457	24.7
1898	3,689,739	372,868	10.1
1899	3,456,342	553,930	16.
1900	3,241,727	282,550	8.7

In a study of the epidemics of the disease, the query naturally arises, what keeps up the infection producing a loss of over $2,-000,000 annually? Why should there be a loss of 256,000 hogs

in one year and 900,000 in another? Why are the herds in the western part of the State attacked in one year and those in the eastern part in a succeeding one? What are the constant and what are the variable factors? Unless these questions can be answered, we are not in a position to apply the knowledge gained in the laboratory to the prevention of the spread of this disease.

In order to obtain definite information as to the presence of the disease and the losses sustained in the State each year, the statistics of the number of hogs produced and the number that died in each township was obtained through the office of the State Statistician. These statistics are believed to be fairly accurate. There are 1,100 townships in the State, and thus the area of each is so small as to be a fairly good working unit. By such divisions, it is possible to study the relation of the disease to streams, elevations, the distribution of the rainfall, to railway lines, to the density of the swine population and to other factors that may appear to have an influence upon the distribution of the infection.

Hog cholera is a disease which closely resembles typhoid fever in the human subject. This resemblance is strong in the character of the sickness, the nature of the lesions which are produced and in the nature and behavior of the germs.

Typhoid fever is a water borne disease, and it is but natural that we might expect that hog cholera should show a similar relationship to the water supply. A study was made of the relation of the disease to the water supply, with the following results:

In 1895 the 60 townships bordering upon the Wabash river, from Cass county to its mouth, show a loss of 150 head out of every 1,000 produced; 47 townships in the second tier removed from the river show a loss of 100 head per 1,000, or 50 per cent. more loss in the first tier than in the second tier. In 1896 the bordering townships lost 294 hogs per 1,000, the second tier 205, and the third tier 160. In other words, the loss was 43.4 per cent. more in the first tier than in the second tier, and 83.8 per cent. more than in the third tier.

In 1895, 44 townships bordering upon the north fork of the White river lost 138 hogs per 1,000, and 42 townships in the second tier 65 hogs per 1,000, or 112 per cent. greater loss in the townships bordering upon the river than in those a few miles removed. In 1896 the loss in the first tier was 231 per 1,000, in the second tier 156, and in the third tier 75, or 48 per cent. greater loss in the first than in the second and 208 per cent. greater than in the third. In 1896, 44 townships bordering upon the

south fork of the White river lost 200 hogs per 1,000; 58 townships in the second tier lost 150, and 42 townships in the third tier lost 109; thus making 33 per cent. more loss in the first than in the second, and 83 per cent. more loss than in the third. In 1897, the first tier of townships bordering upon the river lost 321 hogs per 1,000, the second tier 182, and the third tier 145; 76 per cent. greater loss in the first than in the second, and 121 per cent. more than in the third. During the same period a continuous correspondence was kept up with the breeders of pure bred swine, and it was found that about 90 per cent. of them lost no hogs, while their neighbors suffered severely. In nearly all cases they had used well water, while their neighbors had followed the common practice of using surface water. Doctors Salmon and Smith came to the following conclusions as a result of their investigations: "Perhaps the most potent agents in the distribution of hog cholera are streams. They may become infected with the specific germ when sick animals are permitted to go into them, or when dead animals or any part of them are thrown into the water. They may even multiply when the water is contaminated with fecal discharges or other organic matter. Experiments in the laboratory have determined that the hog cholera bacilli may remain alive in water four months. Making all due allowance for external influences and competition with the bacteria in natural water, we are forced to assume that they may live at least a month in streams. This would be long enough to infect every herd along its course."

It is common practice throughout the State to give the hogs surface water in which to wallow and to drink. Small streams are dammed, drinking places are built into the rivers, a basin is scooped out to receive the water from a barnyard, open ditch, tile drain or spring. All of these afford the best conditions for introducing the germs into the herd. It is not uncommon to go along a public ditch or a stream during an epidemic and find the carcasses of hogs in every stage of decomposition, thus acting as the bearer of infection to new herds. The conditions are better now than ever before, but there are unscrupulous men who will take that means of disposing of their dead, and some one else must suffer.

Had the investigations ceased at this time, the conclusions could not have been otherwise than that it is water borne. If, however, we take the three succeeding years, 1898, 1899 and 1900, we can find no appreciable difference in the townships

bordering on the river and in those more remote. In fact, the percentage is slightly higher in the remote townships. During this same period the number of hogs produced in the river townships remained about the same. Presumably the river contained the same infection and we know that the swine breeders in general made no particular change in the management of their herds. Probably less than one-fourth of the animals remained on the farms more than 10 months, so that new generations have come and gone. Had the animals recovered from an attack of the disease we might attribute this difference to an acquired immunity, but we are not aware that such immunity descends to succeeding generations. The disease has been observed to go up streams as well as down, to move to and from the streams, to attack herds supplied with deep well water and reasonable sanitary conditions as well as those under opposite conditions. The source of the water supply and the general management has remained constant, but the disease has changed locations. I can only conclude therefrom, that the water supply is only one means of dissemination of hog cholera.

In the recent studies upon typhoid fever it has been shown that in addition to the water supply, that flies may be bearers of infection. No such studies have been conducted with reference to the dissemination of hog cholera.

An attempt was made to determine whether a relationship could be traced to a difference in elevation. In other words, is the disease limited to the valleys? The most serious outbreaks have occurred in Knox and Posey counties, the lowest counties in the State, and Union county, the highest county in the State. Indiana is a comparatively level State, but such differences as do exist have no appreciable effect on the distribution of the malady.

An effort was also made to determine whether any relationship could be traced to the amount and distribution of the rainfall. Charts were plotted to show the rainfall for the year and for each month, but the results were of a negative character. In some seasons the disease was largely confined to the dry area and in others it followed the greatest rainfall of the summer and fall months. An attempt was also made to learn what relationship, if any, existed between the density of the swine population and the per cent. of loss. For this purpose the counties were grouped according to the number of hogs which they produced for each square mile, and the percentage of loss compared. These are shown in table VII.

TABLE VII.

Swine population and per cent of loss in Indiana from hog cholera.

Number of hogs per square mile.	Number of counties.	Per cent of loss.
	1883-1890.	
1- 24	1	8.1
25- 49	7	4.5
50- 74	20	5.9
75- 99	12	9.1
100-124	16	8.3
125-149	11	7.9
150-174	7	8.1
175-199	10	8.8
220-224	8	10.
	1895-1900.	
1- 24	2	7.6
25- 49	25	10.3
50- 74	14	13.
75- 99	16	14.9
10-124	12	14.9
125-149	8	16.3
150-174	5	13.2
175-199	8	17.6
220-224	2	17.

It was not possible to make the comparison by townships in this case, as the number of square miles in each township could not be ascertained. In the series of years from 1883 to 1890 there is very little difference in the per cent. of loss, as 12 counties having from 75 to 100 hogs per square mile, lost a slightly higher per cent. than 10 counties having from 175 to 200 hogs per square mile. In the last series of years the loss increases with the increase of swine population. In this connection it must be borne in mind that the counties having the densest swine population are also situated along the streams.

The sections of the State which have been least affected by the disease are the two northern tiers of counties with the exception of St. Joseph and LaPorte, and the southern counties with the exception of those in the extreme southwest. These sections have not been entirely free, but the losses have been very

light. The infected area is that drained by the Wabash river and its tributaries, and the north and south forks of the White river. St. Joseph and LaPorte counties are at the head of the Kankakee river and are also partially drained by the St. Joseph river to the north. They do not produce more hogs than the counties east or south, and have no trunk lines or railroads not common to the adjacent counties, and yet they seem to have a permanent infection.

The disease was also studied with reference to season, and in this respect it is much like typhoid fever. It is present at all times, but is much more epidemic in character in the late summer and fall, and gradually subsides in the winter and spring. Because of this greater prevalence in the fall, many people have held the opinion that the disease is due to the feeding of green corn. Individuals in high positions have committed this error. In 1896, the Iowa Weather Bureau published a map showing the distribution of the disease in that State. It was found that the greatest losses were sustained in those counties where corn constituted an almost exclusive diet. The lowest death rate occurred in those counties which dairying was an important industry and milk was largely used as a food. This was accepted as confirmary evidence of the bad influence of a corn diet. In 1897 the statistics showed just the reverse condition, that is, corn fed hogs suffered least.

The transportation companies are supposed to be responsible for the dissemination of the disease to a very large extent. It is against them that most sanitary officers would direct their first attack in the prevention of the disease. The point constantly urged as the panacea for this scourge is the compulsory disinfection of all cars. If the transportation companies are the offenders, which they are supposed to be, then we should be able to show repeated outbreaks along their right of way in which the evidence would point toward car infection. We can conceive that litter might drop from cars and fall into a stream and cause an outbreak of the disease some miles below and the scourge of infection never be accredited to the real source. For every such outbreak, however, there ought to be many along the right of way in which the evidence would be reasonably clear that it originated from car infection. We would expect that the disease would spread from the railroad to the country in some cases at least. The writer has made an investigation of every outbreak of railroad infection that has been brought to his atten-

tion, and in nearly every instance the outbreak was the result of shipping in stock hogs for feeding purposes. The hogs were either diseased before being shipped or infected from the yards or cars. Seventeen such outbreaks occurred in 1895, and 36 in 1896. During the entire eight years the writer has not found a dozen outbreaks of the disease independent of the shipment of stock, neither has he found the disease to be more prevalent along trunk lines than at points more remote. These studies seem to indicate that the transportation companies are not such grievous offenders. If no hogs were permitted to be withdrawn from stock yards or shipped for feeding purposes, the danger from transportation infection would be largely reduced. The former could be done at very little expense, but the disinfection of all cars would involve an enormous outlay. In the writer's opinion, it will require stronger proof than that yet presented to justify an order for general disinfection of cars.

An attempt was also made to learn how long the germs may live on a premises and infect susceptible animals. The laboratory experiments which have been made would rather indicate that such infection could not continue for a long time, for not more than a few months or at most a couple of years. Field observations to determine the same points are always open to criticism because we cannot guard all the means of infection. The evidence is only circumstantial. Repeated observations have shown that outbreaks of the disease have occurred on farms in from one to three years as the result of hogs rooting out the remains of former victims. The number of such cases reported within one year is quite large, after two years is small and after three years is rare. The writer witnessed an outbreak in which the infection seemed to have remained on premises for four years. An epidemic destroyed a herd that had occupied an abandoned house and some of the carcasses were never removed. The buildings were then closed and no stock had access to it or near it until it was again utilized by hogs four years later. A typical outbreak occurred, and as they were the only hogs affected in that vicinity, it seemed as though the infection had persisted. In another instance the period was seven years. The period during which typhoid may infect a well or anthrax a premises is only determined by circumstantial data upon such cases as will permit the elimination of other factors. If such observations may be accepted for those diseases, why not for hog cholera? If it be true that the germs may live for a year or more in the soil, we can then

account for many outbreaks, the cause of which now seem obscure.

Against such observations as to the duration of the infection, we find hundreds of farmers will place bunches of hogs on premises where the diseased have just been removed and no bad results follow. Others will feed the carcasses of the dead to the living in order to produce an immunity. These diametrically opposite conditions are difficult to understand, with our present knowledge of the disease. Moreover, if the disease germs can live in the soil and produce an infection when a favorable opportunity presents itself, then we would expect infection on the same farms in succeeding years. It is the rule, however, that after a very severe scourge of cholera, that the premises will remain free for a few years. This observation is further verified by the fact that if in a township there is a light loss of from 10 to 20 per cent., the succeeding year the loss will probably be from 30 to 40 per cent. or even more, but after a loss of from 40 to 70 per cent., the following year there will be scarcely any trace of the disease.

This is so universally true that with the series of charts of the distribution of this disease one can predict with considerable accuracy the movements of the disease for the following year. In any locality the herds that escape one year are particularly liable to attack the succeeding year, provided they are kept under conditions similar to the first. Farms on which no cholera has ever existed are less subject to infection than those on which the disease has once gained a foothold.

A study was also made of the relation of age, to the virulence of the infection. Hogs under five months suffer far more than those that are older. Probably not more than 50 per cent. of hogs between the age of five and eight months become affected or die and probably not more than 10 per cent. of those that are above eight months contract the disease when exposed. There are epidemics in which the infection is of such virulent character that a much higher per cent. will become affected. In outbreaks of swine plague a higher per cent. of old hogs die.

Studies were conducted upon some of the minor influences which would disseminate the disease, as exhibitions at fairs and public sales. These are more important factors than are generally supposed. The disease has been carried for long distances in this manner. The present law governing exhibitions of stock is very good in many respects, and during the time it was enforced it saved many times its cost. The disease sometimes occurs as a

local epidemic, covering an area of from 20 to 35 square miles, in which practically every herd will be affected at one time, regardless of the sanitary conditions under which they have been kept. In these local epidemics the disease could not have been spread by river, transportation company, traffic or any other agency within police control. I have witnessed several such small outbreaks, two of which followed local showers and three occurred during a dry period. In such general outbreaks as occurred in 1896, it is impossible to account for the simultaneous appearance of the disease in distant localities and upon hundreds of farms in the same vicinity by any ordinary means of communication that is controllable.

One of the reasons for presenting the foregoing considerations upon hog cholera, is to assist in more clearly defining the true nature of the malady. There is an almost constant demand that States should exercise police power over this disease, the same as in glanders, Texas fever and other maladies. Those most earnest in their demands fail to recognize the difference between these diseases and the size of the problem. There are a few fundamental principles that must be recognized in determining what steps may be taken in exercising police control.

1st. State control may be made a success with those diseases in which the causative agent requires close contact of susceptible animals with infected animals or furnishings to spread the disease. It is against diseases of this class that State control is usually directed. Pleuro pneumonia of cattle belonged to this class and was stamped out. Glanders of horses is the best type that we now find. When a glandered horse is isolated or killed and the barn and harness cleaned, we know that no more cases will spring up from that source. Hog cholera does not belong to this class.

2nd. State control may be made a success with those diseases in which the causative agent, while outside the body is conveyed by some controllabe agent. Such diseases are typhoid fever in man, and Texas fever in cattle. Typhoid fever in cities is almost a thing of the past, where there is a good board of health. The disease germs are conveyed by the water and by securing a pure water supply it can be prevented. Texas fever germs are conveyed by the tick and to prevent the spread of that disease all that is necessary is to guard against the tick. Hog cholera and swine plague do not belong to this class alone, as they are

without doubt spread by many means. Moreover, the effort to secure pure water must be made by the owner.

3rd. State control may be made successful with those diseases in which the germs may live outside of the body for an indefinite time and spread in numerous ways, if some means of immunization be known. The type of such disease in this State is black leg. By vaccination, the cattle in the infected sections may be rendered immune and the loss be reduced to only a very small percentage. Most heroic efforts have been made to secure a system of vaccination or inoculation for the prevention of swine disease. The efforts in this directions have been failures. There are still a few who make claims of success, but their methods can not be duplicated by others with good results. The serum treatment for prevention and treatment from which much was expected and which has been fairly successful in the hands of the government experts, does not promise to be a generally practicable measure. The attempts to duplicate the work by private firms have not been encouraging.

The method of immunizing in utero now so much advertised, has not been used long enough to determine its success or failure.

4th. State control may be made successful if a curative treatment be known. The best example of such a disease is sheep scab. The dipping of sheep and the proper quarantining of affected animals will effectually stamp out the trouble. No known specific has yet been discovered for hog cholera. This Station has used more than two tons of so-called cholera cures. The files at the Patent Office were scanned for every formula, numerous prescriptions were received and all the remedies offered on the market were tested. The results were negative and in this we agree with practically every investigator. The remedies now so much advertised will give way to others in a few years.

5th. State control can only be partially successful with those diseases in which the causative agent may live outside the body for an indefinite time and be carried from place to place by natural agencies and no means of immunization or cure be known. Influenza and strangles in horses and grip in people are types of this class. To know the cause of these diseases does not enable us to control them, further than the efforts of the individual can be exercised in keeping the body in a healthy state by care, food and good sanitary surroundings. In epidemics of swine plague we certainly have an analogous condition.

It is impossible to state definitely how much can be accomplished by police control. The experiments which have been conducted have been of short duration or over too small areas to draw a satisfactory conclusion. In practically all these attempts the reports have been favorable.

In the government experiments in Iowa in 1897, a canvas was made of all the farms to determine how many hogs were lost the year prior and as rapidly as the disease was reported hogs were killed and the premises cleaned. The results seemed to show that a considerable saving had been made by the end of the year. The figures upon the prevalence of the disease in any given locality in the State show that little reliance should be placed in the apparent results unless continued in the same place for several years. There might have been a considerable decrease had nothing been done.

Minnesota makes a more systematic effort to prevent the occurrence of hog cholera than any other State. The work is under the State Board of Health, and there is a general enforcement of quarantine measures against any infected premises and compulsory disinfection. The problem is simple there as compared with the conditions in our own State. The total loss for the whole State of Minnesota is less than in a single county here.

England has tried to stamp out the disease by slaughter and quarantine. No suspected hogs can be shipped from a swine fever district within 60 days from a reported outbreak. Every owner must report all cases at once to the district inspector. All cars must be disinfected after each trip. Prior to 1896 the work was not done under very rigid regulations.

The effect has been to greatly reduce the number of outbreaks and also the number of diseased hogs slaughtered. The dis-

TABLE VIII.

Occurrence of swine plague in England.

Year.	Outbreaks.	Number slaughtered.
1894	5,682	56,296
1895	6,305	69,931
1896	5,166	79,286
1897	2,155	40,764
1898	2,514	43.756

appointing thing is the fact that the infected area remains the same. In the estimation of many it is a question whether the saving in one direction is not offset by the expense of disinfection and annoyance to commence. Five years hence we will be in a better position to estimate the full value of the work.

Indiana sustains an annual loss of over $2,000,000 from these two diseases. They present unusual difficulties for their control and before any system can be recommended or adopted, a much more extensive series of experiments should be undertaken to determine the best method. A complete system of police control such as that employed in England would cost not less than $250,-000, an amount too large to be considered for one moment.

THE PREVALENCE OF SHEEP SCAB.

By A. W. Bitting, M. D., D. V. M.

Sheep scab is one of the diseases for which there can be no excuse offered for allowing it to exist. It is probably the most easily and cheaply eradicated disease of farm animals. It is a truly parasitic affection and the parasites can live off the body of the host for only a short time. It cannot be conveyed from one animal to another except by close contact with affected animals or with the premises where affected animals have been, and it is a disease that can be completely stamped out by treatment. To allow the disease to exist at all is to make dipping a necessity, and this often at a season of the year when it is attended by some loss and a great deal of labor and inconvenience. Could farmers only realize that it costs more to dip newly infected flocks each year because of neglect to dip, or imperfect dipping of scabby sheep, than it would to stamp out the disease, they might demand that the work be done thoroughly at one time.

In order to determine to what extent the disease prevails in this State, a request was made that the State Statistician should include the question among his inquiries. The results of the year 1898 were published in bulletin No. 80. The results for 1899 and 1900 are as follows:

TABLE IX.

The occurrence of sheep scab by counties in Indiana in 1899 and 1900.

COUNTY.	1899.		1900.	
	Number of reports.	Number sheep affected.	Number of reports.	Number sheep affected
Adams	3	169	2	3
Allen	3	11	5	119
Bartholomew	2	5	3	28
Benton	0	0	1	4
Blackford	0	0	1	74
Boone	5	204	5	161
Brown	0	0	1	79
Carroll	5	27	2	57
Cass	5	18	2	20
Clark	2	4	4	35
Clay	5	21	3	9
Clinton	5	188	6	122

TABLE IX—Continued.

COUNTY.	1899. Number of reports.	1899. Number sheep affected.	1900. Number of reports.	1900. Number sheep affected.
Crawford	2	14	3	19
Daviess	2	12		
Dearborn	0	0	1	2
Decatur	0	0	3	9
DeKalb	2	35	1	1
Delaware	3	409	8	344
Dubois	6	39	6	44
Elkhart	6	121	5	284
Fayette	3	248	3	11
Floyd	1	3	1	10
Fountain	7	149	6	143
Franklin	8	361	5	241
Fulton	3	159	1	29
Gibson	5	35	2	6
Grant	8	404	2	12
Greene	2	4	2	9
Harrison	4	18	2	16
Hancock	5	372	7	340
Hamilton	6	595	4	88
Hendricks	8	290	5	416
Henry	2	71	5	26
Howard	5	49	5	17
Huntington	5	196	3	67
Jackson	3	22	4	35
Jasper	1	3	3	46
Jay	7	269	6	96
Jefferson	3	12	4	30
Jennings	5	23	7	39
Johnson	6	55	5	75
Knox	3	20	3	28
Kosciusko	3	36	4	72
LaGrange	3	240	0	0
Lake	0	0	1	1
LaPorte	6	69	0	0
Lawrence	0	0	1	1
Madison	4	21	8	259
Marion	6	102	5	152
Marshall	3	5	3	145
Martin	3	63	3	78
Miami	5	95	4	40
Monroe	6	36	1	116
Montgomery	8	798	8	859

TABLE IX—Continued.

COUNTY.	1899		1900.	
	Number of reports.	Number sheep affected.	Number of reports.	Number sheep affected.
Morgan	5	422	4	147
Newton	5	422	4	147
Newton	0	0	1	42
Noble	3	10	0	0
Ohio	0	0	1	34
Orange	5	33	2	21
Owen	4	20	3	30
Parke	3	205	4	40
Perry	1	3	3	23
Pike	4	27	4	57
Porter	3	22	2	53
Posey	3	11	2	20
Pulaski	1	2	0	0
Putnam	5	109	6	263
Randolph	6	38	3	20
Ripley	2	87	4	32
Rush	5	229	6	74
Scott	1	1	0	0
Shelby	2	22	3	10
Spencer	2	4	4	13
Starke	2	7	0	0
Steuben	2	5	1	3
St. Joseph	3	32	2	4
Sullivan	4	842	5	453
Switzerland	3	30	0	0
Tippecanoe	5	39	4	162
Tipton	2	269	1	200
Union	1	28	2	12
Vanderburgh	1	5	0	0
Vermillion	1	14	1	1
Vigo	2	13	2	7
Wabash	2	24	4	10
Warren	5	179	2	26
Warrick	6	21	0	0
Washington	3	9	1	2
Wayne	6	52	5	20
Wells	5	260	7	480
White	2	75	6	96
Whitley	4	73	1	4
	320	9,338	287	7,192

An inquiry addressed to the owners of these sheep showed that they had called a sheep scabby when it had a rough coat and not produced by the scab parasite. This was true for many reports of from one to five or six. In 1899 the report showed a total of 9,338 affected sheep. Our estimate was that there were about 7,500 head of true scabby sheep. This year the report shows 7,192 scabby sheep and our estimate based upon later correspondence is that there are about 5,700 true cases. This is a fair decrease, but is not as large as it should be. There is less disease being spread now by shipment than formerly, as farmers have learned that the rules and regulations upon dipping at stock yards are very rigidly enforced and fewer affected animals are sent in.

Our own State laws are inadequate to handle the disease properly.

a. **Fig. 1.** *b.*

Two healthy tomatoes removed from the vines for artificial infection. Photographed prior to inoculation March 2, 1899.

c. **Fig. 2.** *d.*

The same fruits as shown in Figure 1 twenty days after infection. Tomato a, infection material smeared over outer surface of the fruit not producing any results as shown at c. Tomato b, infection material introduced into the tissues of the fruit, producing a breaking down of the tissues as shown at d. Photographed March 22, 1899.

UPON THE OCCURRENCE OF RABIES.

By A. W. Bitting, M. D., D. V. M.

In 1896 and 1898 an attempt was made to collect such data as would give a fair notion of the prevalence and comparative frequency of a number of the more important diseases. One of these diseases was hydrophobia. According to the reports received at that time there were about 12 genuine cases reported in the practice of 20 veterinarians for each year. In February of the present year a query was again directed to all the veterinarians in the State and from their reports it is believed that the number of cases each year is about the same as shown in the former work. The newspapers frequently make reports upon the disease and so often they prove to be erroneous that many people, including physicians, do not believe that such a disease exists. People are rarely affected and the human physician has little opportunity to witness its effects. The veterinarian does occasionally see affected animals, but these as a rule do not exhibit all those terrifying characteristics so popularly described. The disease does occur with sufficient frequency to demand attention, but ought not be treated from either the standpoint of the alarmist nor as a myth.

Two well defined outbreaks of rabies have occurred within the immediate vicinity of the Station, one in 1892, at which time three dogs and a number of sheep and hogs were affected. The second occurred in the summer of 1898, at which time two dogs, three horses and three cows died. Shortly after this time five other animals were suspected of being diseased and were killed, but we had no opportunity of making an examination. On April 10 of the present year a fox terrier was received at the infirmary affected with the disease. The history and symptoms of the cases that occurred in 1898 were about as follows: In the latter part of June, the farm dog had a fight with a peddler's dog. The farm dog was naturally very lazy, but on July 12 he showed unusual activity and followed the farmer part of the day behind the plow. Once in a while he was noticed to snap at the farmer's legs, but not viciously and no notice was taken. On the 13th he was still more active, followed the plowing and once or twice snapped so viciously as to attract attention. While the house was being swept he snapped so viciously at the broom that he had to be put out. On the 14th he became cross to the stock and was

seen to bite two horses and later became so cross that it was necessary to shoot him. One of the horses became sick on the 5th of August. He began by looking dull and stupid, with intervals of unusual sensitiveness to all surroundings. He was attracted by all noises, refused to eat more than a small amount, would stand and shake the head, champ the jaws, salivate and bite at other stock or at persons. At first he would obey the owner, but rapidly became violent, tried to tear down the stall, and was shot. The second horse became affected on August 31. He was observed to be nervous and restless, all the time apparently paying attention to something at a distance. The horse showed unusual viciousness toward other horses in adjoining stalls, but did not offer to injure the owner. He would stand and rub the nose against the manger until it was raw. The horse was led five miles to the University. The nervousness increased and the animal would be startled at the least noise. The horse ate and drank Friday and Saturday morning, but was unable to do so in the afternoon. Slight spasms of the neck muscles were observed about Saturday noon and there were brief general convulsions in the afternoon. There was continued walking, viciousness developed to an extreme degree. The animal would sit on the haunches and paw at the ceiling, and would rush at the walls in a frantic manner. He would seize his legs with his teeth and take out large pieces of flesh. There were periods of paralysis of the muscles of the neck and chest so that breathing was accomplished with great difficulty. He died of convulsions during the night. The third horse soon became affected on the evening of September 1 and the case developed so rapidly that it was necessary to kill her on the next morning.

One cow became affected on August 20 and was shot on August 23; one died September 1; and another was shot September 12. These cattle were probably bitten on July 14, the date when the horses were known to have been bitten. The symptoms in the cattle developed less rapidly than in the horse. They were first observed to be nervous, to step from side to side in the stable, to suddenly cease chewing and to gaze in a fixed manner upon some object usually at considerable distance. They would eat and drink part of the time. The genesic instinct was intense. They would paw and bellow like the male. A pregnant heifer began straining and aborted. The eyes were wild and staring and saliva flowed from the mouth. In the effort to get out of the stall one animal inflicted a great deal of injury to

herself. There was paralysis of the muscles of the neck and back, so that there was the same difficulty in swallowing and breathing as in the horse. Death came during a convulsion in the animal that was kept for observation.

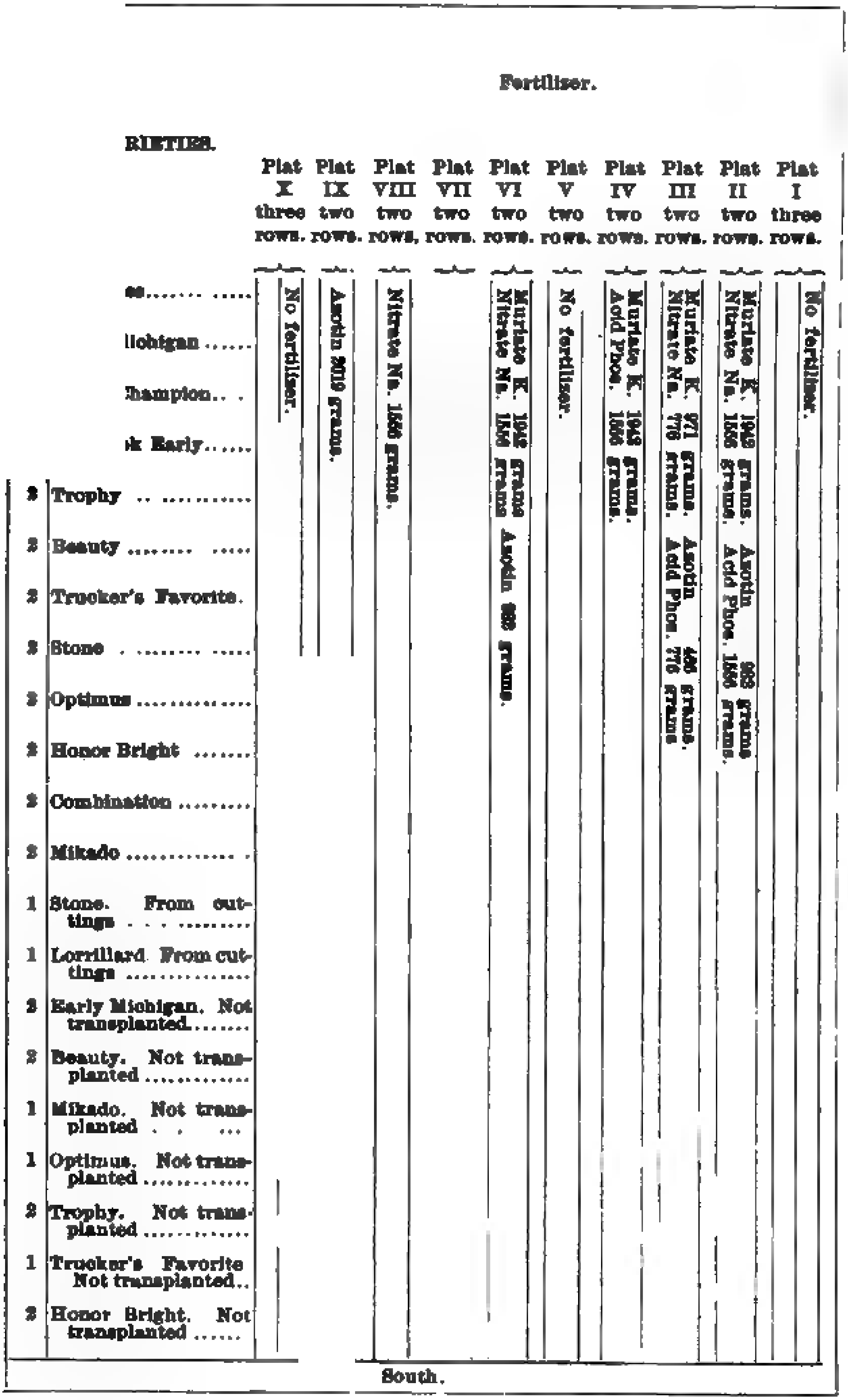
In the dog we have the period of nervous excitation during which time the animal is alert and active; a period of madness during which time he will attack anything and inflict self injury. During this period there will be intervals during which the animal will be perfectly quiet and apparently intently thinking. The animal becomes cross and will attack anything; will keep on the move and the genesic instinct may amount to a nymphomania. The final stage is that of paralysis, when groups of muscles in different parts of the body are affected. The power of swallowing is lost. The lower jaw may be paralyzed and respiration may be performed with the greatest difficulty. These different periods merge into one another so that they cannot be separated by any well defined interval. The diseases with which hydrophobia are most often confounded in cattle are mad itch, due to impaction with dry feed, and bassilar meningitis in horses and dogs. In all of these diseases the history and development of the symptoms are different and will so appear when closely observed.

FERTILIZER TESTS ON DIFFERENT VARIETIES OF TOMATOES.

By James Troop.

During the season of 1899 a number of experiments with commercial fertilizers on tomatoes were carried on in the different parts of the State under the immediate supervision of the Station chemist. In this same connection a similar test was made on the Experiment Station grounds in connection with the work of the horticulturist. Some interesting results were obtained, although they were not so well marked in all cases owing to the fact that the soil on the Experiment Station farm is naturally more fertile than that upon which the same experiments were tried in other portions of the State. The soil selected was a rather heavy, sandy loam, naturally underdrained and sloping slightly to the south. The plat occupied a space 162 by 99 feet or 16,038 square feet. Twelve varieties were used in the experiment. The plants were all started from seed in the greenhouse, except two varieties which were started from cuttings, and a portion of these were transplanted once from the seed bed into pots before planting them out into the open ground. The others were not transplanted at all, but taken directly from the seed bed to the open ground. The varieties were planted in rows running east and west, while the fertilizer plats ran north and south, across the varieties as shown in the following diagram.

Diagram Showing the Arrangement of the Plats.



Tables X to XIX show the results obtained from the ten different plats, with and without fertilizers, each plat having the same varieties, and each plat consisting of two rows, excepting Nos. 1 and 10, which had three each. These tables give the kind and amount of fertilizer, number of plants per plat, number of pounds of fruit per plat, average number of pounds per plant, number of fruits per plat, average number of fruits per plant and the number of rotten fruits per plat.

The first fruits were picked July 20, and the last on September 25. Much the larger part of the crop, however, was picked between August 1st. and September 5th.:

TABLE X.

The influence of fertilizers on yields of tomatoes.

PLAT I. No fertilizer. Variety.	Number plants per plat	Number pounds fruit per plat.	Average pounds fruit per plant.	Number fruits per plat.	Average number fruits per plant.	Number rotten fruits per plat.
Matchless	6	60	10	230	38 1—3	15
Early Michigan	6	55	9 1—6	290	48 1—3	12
Dwf. Champion	3	11	3 2—3	57	19	11
Fordhook Early	6	12	2	175	29 1—6	6
Trophy	6	64	10 2—3	242	40 1—3	10
Beauty	6	69	11½	287	48	16
Trucker's Favorite	6	77	12 5—6	271	45 1—6	13
Stone	6	89	14 5—6	276	46	18
Optimus	6	89	14 5—6	390	65	22
Honor Bright	6	68	11 1—3	238	39 2—3	14
Combination	6	79	13 1—6	301	50 1—6	10
Mikado	6	82	13 2—3	199	33 1—6	20
Stone (from cuttings)	3	34	11 1—3	112	37 1—3	9
Lorrillard (from cuttings	3	31	10 1—3	133	44 1—3	11
Early Mich., not transplanted.	6	84	14	447	74½	9
Beauty, not transplanted	6	72	12	308	51 1—3	16
Mikado, not transplanted	3	47	15 2—3	104	34 2—3	24
Optimus, not transplanted	3	22	7 1—3	93	31	7
Trophy, not transplanted	6	63	10½	217	36 1—6	25
Trucker's Fav., not transplan't	3	46	15 1—3	168	56	25
Honor Bright, not transpla'ted	6	44	7 1—3	158	26 1—3	13
TOTALS	108	1198	11.1	4696	42.5	306

TABLE XI.

The influence of fertilizers on yields of tomatoes.

PLAT II. Muriate Potash..............1942 gr. Nitrate Soda................1556 gr. Azotin ....982 gr. Acid Phosphate..............1556 gr.	Number plants per plat.	Number pounds fruit per plat.	Average pounds fruit per plant.	Number fruits per plat.	Average number fruits per plant.	Number rotten fruits per plat.
Matchless	4	54	13½	223	55¾	23
Early Michigan	4	34	8½	205	51¼	14
Dwf. Champion	2	8	4	45	22½	3
Fordhook Early	4	22	5½	114	28½	3
Trophy	4	48	12	228	57	16
Beauty	4	43	10¾	169	42¼	21
Trucker's Favorite	4	41	10¼	180	45	17
Stone	4	43	10¾	165	41¼	9
Optimus	4	52	13	287	71¾	14
Honor Bright	4	40	10	184	46	5
Combination	4	51	12¾	263	65¾	9
Mikado	4	58	14½	153	38¼	22
Stone (from cuttings)	2	35	17½	108	54	11
Lorrillard (from cuttings	2	27	13½	127	63½	7
Early Mich., not transplanted.	4	51	12¾	261	65¼	12
Beauty, not transplanted	4	70	17½	236	59	12
Mikado, not transplanted	2	41	20½	117	58½	14
Optimus, not transplanted	2	33	16½	209	104½	12
Trophy, not transplanted	4	57	14¼	77	14¼	9
Trucker's Fav., not transplan't	2	42	21	153	76½	7
Honor Bright, not transpla'ted	3	27	9	104	26	5
TOTALS	72	877	12 1—5	3608	50 1—9	245

TABLE XII.

The Influence of fertilizers on yields of tomatoes.

PLAT III. **Muriate Potash**..............**9719 gr.** **Nitrate Soda**............ ..... **776 gr.** **Azotin**........................ **466 gr** **Acid Phosphate**.............. **776 gr.** VARIETY.	Number plants per plat.	Number pounds fruit per plat.	Average pounds fruit per plant.	Number fruits per plat.	Average number fruits per plant.	Number rotten fruits per plat.
Matchless	4	36	9	134	33½	12
Early Michigan..............	4	35	8¾	183	45¾	12
Dwf. Champion..............	2	10	5	60	30	6
Fordhook Early..............	4	24	6	119	29¾	1
Trophy	4	39	9¾	182	45½	1
Beauty	4	36	9	138	34½	19
Trucker's Favorite...........	4	50	12½	145	36¼	8
Stone	4	40	10	133	38¼	13
Optimus	4	47	11¾	211	52¾	13
Honor Bright...............	4	46	11½	167	41¾	10
Combination	4	52	13	133	33¼	9
Mikado	4	55	13¾	144	36	16
Stone (from cuttings)........	2	28	14	103	51½	5
Lorrillard (from cuttings.....	2	25	12½	89	44½	2
Early Mich., not transplanted.	4	42	10½	206	51½	18
Beauty, not transplanted......	4	59	14¾	266	66½	7
Mikado, not transplanted.....	2	36	18	133	66½	16
Optimus, not transplanted....	2	44	22	237	118½	8
Trophy, not transplanted.....	4	45	11¼	221	55¼	8
Trucker's Fav., not transplan't	2	35	17½	118	59	12
Honor Bright, not transpla'ted	4	45	11¼	199	49¾	27
TOTALS................	72	829	11½	3321	48 3—5	223

TABLE XIII.

The influence of fertilizers on yields of tomatoes.

PLAT IV. Muriate Potash ....1942 gr. Acid Phosphate ....1556 gr. VARIETY.	Number plants per plat.	Number pounds fruit per plat.	Average pounds fruit per plant.	Number fruits per plat.	Average number fruits per plant.	Number rotten fruits per plat.
Matchless	4	51	12¾	200	50	18
Early Michigan..............	4	41	10¼	200	50	11
Dwf. Champion..............	2	11	5½	51	25½	8
Fordhook Early..............	4	27	6¾	130	32½	15
Trophy	4	53	13¼	228	57	21
Beauty	4	52	13	194	48½	8
Trucker's Favorite...........	4	54	13½	115	28¾	13
Stone	4	59	14¾	193	48¼	18
Optimus	4	53	13¼	268	67	11
Honor Bright................	4	45	11¼	168	42	6
Combination	4	56	14	198	49½	9
Mikado	4	62	15½	136	34	17
Stone (from cuttings)........	2	40	20	145	72½	9
Lorrillard (from cuttings.....	2	22	11	97	48½	7
Early Mich., not transplanted.	4	50	12½	212	53	6
Beauty, not transplanted......	4	54	13½	240	60	11
Mikado, not transplanted.....	2	29	14½	78	39	5
Optimus, not transplanted....	2	27	13½	141	70½	1
Trophy, not transplanted.....	4	47	11¾	171	42¾	5
Trucker's Fav., not transplan't	2	29	14½	147	73	7
Honor Bright, not transpla'ted	4	50	12½	204	51	17
TOTALS................	72	918	12¾	3516	50	223

TABLE XIV.

The influence of fertilizers on yields of tomatoes.

PLAT V. No fertilizer. VARIETY.	Number plants per plat.	Number pounds fruit per plat.	Average pounds fruit per plant.	Number fruits per plat.	Average number fruits per plant.	Number rotten fruits per plat.
Matchless	4	30	7½	155	38¾	8
Early Michigan	4	40	10	209	52¼	13
Dwf. Champion	2	16	8	69	34½	2
Fordhook Early	4	27	6¾	125	31¼	27
Trophy	4	43	10¾	141	35¼	7
Beauty	4	46	11½	180	45	9
Trucker's Favorite	4	46	11½	157	39¼	20
Stone	4	45	11¼	149	37¼	12
Optimus	4	40	10	165	41¼	9
Honor Bright	4	46	11½	176	44	5
Combination	4	44	11	184	46	7
Mikado	4	49	12¼	130	32½	10
Stone (from cuttings)	2	27	13½	76	38	6
Lorrillard (from cuttings	2	18	9	85	42½	8
Early Mich., not transplanted	4	33	8¼	169	42¼	7
Beauty, not transplanted	4	31	7¾	128	32	1
Mikado, not transplanted	2	22	11	57	28½	8
Optimus, not transplanted	2	28	14	155	77½	2
Trophy, not transplanted	4	31	7¾	153	38¼	4
Trucker's Fav., not transplan't	2	22	11	129	64½	9
Honor Bright, not transpla'ted	4	31	7¾	123	30¾	9
TOTALS	72	715	9.9	2915	41.5	183

TABLE XV.

The influence of fertilizers on yields of tomatoes.

PLAT VI. Muriate potash..............1942 gr. Nitrate soda..................1556 gr Azotin.......................988 gr. VARIETY.	Number plants per plat.	Number pounds fruit per plat.	Average pounds fruit per plant.	Number fruits per plat.	Average number fruits per plant.	Number rotten fruits per plat.
Matchless	4	34	8½	126	31½	9
Early Michigan..............	4	51	12¾	203	50¾	4
Dwf. Champion..............	2	13	6½	48	24	7
Fordhook Early..............	4	33	8¼	171	42¾	9
Trophy	4	43	10¾	162	40½	11
Beauty	4	41	10¼	163	40¾	21
Trucker's Favorite...........	4	45	11¼	168	42	14
Stone	4	42	10½	124	31	8
Optimus	4	39	9¾	189	47¼	8
Honor Bright................	4	39	9¾	151	37¾	8
Combination	4	43	10¾	181	45¼	21
Mikado	4	58	14½	102	35½	0
Stone (from cuttings).....	2	23	11½	82	41	3
Lorrillard (from cuttings.....	2	23	11½	101	50½	1
Early Mich., not transplanted.	4	35	8¾	181	45¼	6
Beauty, not transplanted......	4	45	11¼	170	42½	16
Mikado, not transplanted.....	2	26	13	77	38½	5
Optimus, not transplanted....	2	21	10½	108	54	6
Trophy, not transplanted.....	4	35	8¾	112	28	5
Trucker's Fav., not transplan't	2	25	.12½	96	48	5
Honor Bright, not transpla'ted	4	20	5	77	19¼	6
TOTALS................	72	734	10½	2792	40	163

TABLE XVI.

The influence of fertilizers on yields of tomatoes.

PLAT VII. Nitrate of soda.... ....1556 gr. Azotin.......................... 983 gr. Acid phosphate ....1556 gr. VARIETY.	Number plants per plat.	Number pounds fruit per plat.	Average pounds fruit per plant.	Number fruits per plat.	Average number fruits per plant.	Number rotten fruits per plant.
Matchless	4	36	9	146	39	4
Early Michigan..............	4	37	9¼	183	45¾	14
Dwf. Champion..............	2	20	10	97	48½	2
Fordhook Early..............	4	21	5	106	26½	3
Trophy	4	39	9¾	116	29	7
Beauty	4	35	8¾	127	31¾	9
Trucker's Favorite...........	4	38	9½	135	33¾	9
Stone	4	32	8	102	25½	11
Optimus	4	40	10	170	42½	9
Honor Bright................	4	37	9¼	122	30½	3
Combination	4	44	11	155	38¾	10
Mikado	4	39	14¾	99	24¾	10
Stone (from cuttings)........	2	24	12	79	39½	1
Lorrillard (from cuttings.....	2	22	11	140	70	14
Early Mich., not transplanted.	4	33	8¼	169	42½	0
Beauty, not transplanted......	4	49	12¼	243	60¾	7
Mikado, not transplanted.....	2	23	11½	98	49	6
Optimus, not transplanted....	2	12	12	53	26½	2
Trophy, not transplanted.....	4	33	8¼	109	27¼	2
Trucker's Fav., not transplan't	2	14	7	70	35	3
Honor Bright, not transpla'ted	4	44	11	94	23½	2
TOTALS................	72	672	9.9	2613	38	128

TABLE XVII.

The infuence of fertilizers on yields of tomatoes.

PLATT VIII. Nitrate Soda.................1556 gr. VARIETY.	Number plants per plat.	Number pounds fruit per plat.	Average pounds fruit per plant.	Number fruits per plat.	Average number fruits per plant.	Number rotten fruits per plat.
Matchless	4	50	12½	119	29¾	23
Early Michigan..............	4	32	9	161	40¼	3
Dwf. Champion..............	2	12	6	64	32	5
Fordhook Early..............	4	23	5¾	95	23¾	3
Trophy	4	46	11½	106	26½	12
Beauty	4	42	10½	143	35¾	16
Trucker's Favorite...........	4	44	11	145	36¼	20
Stone	4	44	11	118	29½	10
Optimus	4	59	14¾	211	52¾	8
Honor Bright................	4	47	11¾	158	39½	7
Combination	4	57	14¼	231	57¾	7
Mikado	4	53	13¼	109	27¼	14
Stone (from cuttings)........	2	27	13½	69	34½	6
Lorrillard (from cuttings.....	2	27	13½	105	52½	5
Early Mich., not transplanted.	4	40	10	252	63	3
Beauty, not transplanted......	4	51	12¾	207	51¾	8
Mikado, not transplanted.....	2	25	12½	66	33	2
Optimus, not transplanted....	2	25	12½	48	24	0
Trophy, not transplanted.....	4	33	8¼	127	31¾	3
Trucker's Fav., not transplan't	2	23	11½	116	58	3
Honor Bright, not transpla'ted	4	37	9¼	138	34½	7
TOTALS................	72	797	11.25	2768	38.8	165

TABLE XVIII.

The influence of fertilizers on yields of tomatoes.

PLAT IX. Azotin ....2019 gr. VARIETY.	Number plants per plat.	Number pounds fruit per plat.	Average pounds fruit per plant.	Number fruits per plat.	Average number fruits per plant.	Number rotten fruits per plat.
Matchless	4	43	10¾	145	36¼	13
Early Michigan	4	35	8¾	153	38¼	9
Dwf. Champion	2	15	7½	61	30¼	8
Fordhook Early	4	23	5¾	87	41¾	4
Trophy	4	39	9 2—3	127	31¾	10
Beauty	4	43	10¾	154	38½	12
Trucker's Favorite	4	53	13¼	172	43	19
Stone	4	43	10¾	133	33¼	14
Optimus	4	59	14¾	251	62¾	5
Honor Bright	4	58	14½	212	53	7
Combination	4	70	17½	329	82¼	14
Mikado	4	60	15	146	36½	28
Stone (from cuttings)	2	27	13½	91	45½	3
Lorrillard (from cuttings	2	25	12½	124	62	1
Early Mich., not transplanted.	4	29	7¼	179	44¾	8
Beauty, not transplanted	4	51	13¾	221	55¼	7
Mikado, not transplanted	2	38	19	93	46½	8
Optimus, not transplanted	2	35	17½	67	33½	4
Trophy, not transplanted	4	45	11¼	171	42¾	2
Trucker's Fav., not transplan't	2	28	14	139	69	13
Honor Bright, not transpla'ted	4	33	8¼	126	31½	10
TOTALS	72	850	12.25	3181	45.66	199

TABLE XIX.

The influence of fertilizers on yields of tomatoes.

PLAT X. No fertilizers. VARIETY.	Number plants per plat.	Number pounds fruit per plat.	Average pounds fruit per plant.	Number fruits per plat.	Average number fruits per plant.	Number rotten fruits per plat.
Matchless	6	59	9 5—6	230	38 1—3	4
Early Michigan	6	54	9	302	50 1—3	6
Dwf. Champion	3	23	7 2—3	66	22	4
Fordhook Early	6	35	5 5—6	185	30 5—6	6
Trophy	6	60	10	263	43 5—6	7
Beauty	6	60	10	234	39	3
Trucker's Favorite	6	80	13 2—3	304	50 2—3	8
Stone	6	69	11½	195	32½	3
Optimus	6	90	15	365	60 5—6	8
Honor Bright	6	85	14 1—6	243	40½	5
Combination	6	99	16½	369	61½	9
Mikado	6	91	15 1—6	203	33 5—6	10
Stone (from cuttings)	3	39	13	159	53	5
Lorrillard (from cuttings	3	39	13	201	67	4
Early Mich., not transplanted.	6	51	8½	488	81 1—3	7
Beauty, not transplanted	6	72	12	342	57	4
Mikado, not transplanted	3	59	19 2—3	178	59 1—3	5
Optimus, not transplanted	3	45	15	140	46 2—3	8
Trophy, not transplanted	6	67	11 1—6	233	38 5—6	6
Trucker's Fav., not transplan't	3	47	15 2—3	229	76 1—6	8
Honor Bright, not transpla'ted	6	51	8½	274	45 2—3	4
TOTALS	108	1271	11.76	5403	49	124

A comparison of total yields of the different plats after reducing to the same number of rows, as affected by the various combinations of fertilizers, and those having no fertilizers, is given below, plat 3 receiving just one half as much fertilizer as plat 2:

TABLE XX.

Summary of tomato fertilizer results.

No. plat.	FERTILIZER USED.	Total yield plat.
1.	None	799 lbs.
2.	Muriate potash, nitrate soda, azotin, acid phosphate.	877 lbs.
3.	Muriate potash, nitrate soda, azotin, acid phosphate.	829 lbs.
4.	Muriate potash, acid phosphate....................	918 lbs.
5.	None	715 lbs.
6.	Muriate potash, nitrate soda, azotin................	734 lbs.
7.	Nitrate soda, azotin, acid phosphate...............	672 lbs.
8.	Nitrate soda	797 lbs.
9.	Azotin	850 lbs.
10.	No fertilizer	847 lbs.

TRANSPLANTING VS. NON-TRANSPLANTING.

By James Troop.

As will be seen by referring to the previous tables, the following varieties were duplicated, one set was transplanted and the other planted directly from the seed bed, viz:—Early Michigan, Beauty, Mikado, Optimus, Trophy, Trucker's Favorite, and Honor Bright. Contrary to the general opinion held among gardeners, when we sum up the general averages of yields per plant of all varieties, we find that those which were not transplanted were ahead of the others and the result stands thus:

TABLE XXI.

Table showing average yield of varieties, transplanted and not transplanted.

VARIETY.	Transplanted.	Not transplanted.
Early Michigan...........	9.87 lbs.	11.07 lbs.
Beauty	11.02 lbs.	11.95 lbs.
Mikado	14.04 lbs.	17.26 lbs.
Optimus	12.83 lbs.	14. 1 lbs.
Trophy	11. 1 lbs.	10.43 lbs.
Trucker's Favorite........	11.97 lbs.	14.13 lbs.
Honor Bright.............	11. 5 lbs.	9. 0 lbs.

CUTTINGS VS. TRANSPLANTED PLANTS.

By James Troop.

Cuttings were taken from plants of the Stone variety which had already borne a heavy crop in the green house, and after having rooted, were planted under the same conditions as the transplanted plants raised from seed, with the following result:

Stone from cutting............15 lbs. per plant.
Stone from seed...............11.32 lbs. per plant.

A difference in favor of cuttings of 3.68 per plant.

FERTILIZER EXPERIMENTS WITH TOMATOES IN GREEN-HOUSE.

By James Troop.

The Stone variety was used for this experiment. The plants were transplanted once before being planted into permanent quarters in the greenhouse. They occupied the center bed, so that they received practically the same amount of sunlight and heat. They were transplanted September 25 and the first ripe fruit was picked December 16. The following table gives the plats, the kind and amount of fertilizer which each plant contained, and the weight of the fruit which each fertilized plat produced:

TABLE XXII.

Fertilizers on tomatoes in greenhouse.

Plat.	Fertilizers used.	Weight of fruit.	
		pounds.	ounces
1	Muriate K. 100 grams............... Nitrate Na 80 grams................ Tankage 50 grams.................. Acid phosphate 80 grams............	51	00
2	Check.		
3	Muriate K. 100 grams............... Nitrate Na 80 grams................	50	6
4	Check.		
5	Muriate K. 100 grams.............. Acid phosphate......................	47	10
6	Check.		
7	Muriate K. 100 grams............... Nitrate Na 80 grams................ Tankage 80 grams..................	53	00
8	Check.		
9	Nitrate Na 80 grams............... Acid phosphate 80 grams........... Tankage 50 grams..................	55	14

SUB VS. SURFACE IRRIGATION OF TOMATOES IN THE GREENHOUSE.

By James Troop.

This was a repetition of a similar experiment along this line given in last year's report from this department. The sub-irrigated bed was lined with zinc and a layer of soft bricks for soil. Water was applied from below. The surface irrigated bed was five inches deep, filled with soil, and watered entirely from the surface.

The results obtained from this test during the winter of 1899 were slightly in favor of the surface irrigation, so far as number of fruits and weight were concerned, but the fruits from the sub-irrigated plat were much larger and finer in every way. The results of the present season's tests are given below. They show a decided gain in weight of fruit from the sub-irrigated plat, although the surface irrigated plants produced the greatest number of fruits.

TABLE XXIII.

Showing yield of sub vs. surface irrigation.

	Number fruits.	Weight of fruit lbs. ozs.
Sub-irrigated	389	82 8
Surface-irrigated	399	71 12
		Average weight per fruit
Sub-irrigated		2.88 ozs.
Surface-irrigated		3.39 ozs.

VARIATION IN INDIVIDUAL PLANTS.

By James Troop.

It often happens that a single plant in a series of tests like the above, will influence the yield to a considerable extent, so that the true difference produced by a different combination of fertilizers is not always apparent. In order to test the amount of variation in individual plants, 14 plants were selected from a lot that were as nearly uniform in size and vigor of growth as possible, and these were planted in the green house and treated ex-

actly alike so far as it was possible to do so. The results of these tests gave a maximum variation in number of fruits produced by each plant of 75 per cent. Some individual plants produced nothing but small fruits throughout the season. The maximum variation in the weight of fruit produced by each plant was only one and one-fourth pounds. This emphasizes the importance of selectıng the very best individual plants from which to obtain seed.

LOCATION OF SAN JOSE SCALE IN INDIANA.

By James Troop.

A part of the duties of the horticulturist has been to investigate the ravages of the San Jose scale in the orchards and nurseries of the State. The inspection of nurseries has for the most part been done by assistants appointed for that purpose, but the investigation of orchards has very largely been done in person. Previous to 1899 the San Jose scale had been found in nine counties in this State. Since that time eight more have been found to be infested, making 17 counties that have been more or less infested. These are LaPorte, LaGrange, DeKalb, Miami, Howard, Wayne, Marion, Morgan, Jefferson, Washington, Clark, Gibson, Vigo, Clay, Vanderburg, Ferry and Switzerland. Of these, LaPorte, LaGrange, DeKalb, Morgan, Howard and Switzerland are apparently free from the scale at the present time, owing to the persistent efforts of the owners of the infested orchards in following instructions given to destroy all badly infested trees, and to freely use the spray pump on the others.

Judging from our present knowledge of the situation, the worst infested localities are found in the city of Indianapolis, near the city of Evansville, and on the "Knobs" in Washington and Clark counties.

SWAMP MUCK.

By H. A. Huston and A. H. Bryan.

In many parts of Indiana muck beds are found which vary in area from a fraction of an acre to over 5,000 acres. The formation of these beds is due to the growth and decay of aquatic plants. Where the plants fall down and are covered with water, only a portion of the organic matter is lost and the remainder forms layers of organic matter which is preserved by the action of the water and is commonly known as muck. The material commonly called peat is derived from mosses which grow in wet places. The lower part of the mosses decay and gradually pass into what is known as peat.

Muck and peat soils are exceedingly fertile, and when properly drained form our best corn lands. They are also used to some extend for celery and onions.

It often happens that muck lands that have been laid with tile in the usual manner are not productive. The trouble is generally with the drainage. On a very limited area the trouble may be due to the presence of iron-compounds. The improvment of unproductive muck lands has been discussed in bulletin 57 of this Station.

A muck bed is a valuable adjunct to a farm. Not only may very profitable crops be raised upon it when properly drained, but the muck itself may be used as a manure for the less fertile portions of the farm. The chief manurial ingredient in it is nitrogen. Different samples show from one half to three per cent. of nitrogen in the air dry material. The other fertilizer ingredients are usually present in smaller amounts. The muck may be applied directly to the land, but the better method is to use it as an absorbent for liquid manures. Its high capacity for holding water makes it very useful for this purpose and it will also fix the ammonia formed in the decomposition of the manure. Raw muck does not decompose very rapidly, but when mixed with manure the fermentation of the manure extends to the muck and renders its plant food much more readily available. When it is desirable to use it directly on the land without mixing with manure its texture can be much improved by exposing it in piles to the freezing and thawing action during the winter.

Many of the Indiana muck beds are underlaid with a bed of marl which is composed mainly of carbonate of lime, and to this

reference will be made in another article. Mucks vary so much in composition that no average composition can be given which would serve as an approximate standard for reference.

Such Indiana mucks as have been examined are of high quality. Since mucks have such a high capacity for holding moisture it is best to make comparisons on the material from which all moisture has been removed, or what is known as the water free basis.

The three following Indiana muck soils have been under cultivation about 20 years and have been continuously in corn. The land produces about 70 bushels of corn per acre.

The portion included in the soil is the part turned by the plow and is the top six inches. The land gradually compacts and each year the plow turns up one-quarter to one-half inch of the subsoil that has not been previously disturbed. The subsoil included the black muck between the soil layer and the point where the raw muck of brown color was found. The average thickness of this black subsoil was about 20 inches.

Nitrogen in water-free muck.

Soil No. 1	3.61 per cent.
Subsoil No. 1	2.75 per cent.
Soil No. 2	4.00 per cent.
Subsoil No. 2	4.14 per cent.
Soil No. 3	3.83 per cent.
Subsoil No. 3	3.38 per cent.

These mucks when fully dry contained about one-half mineral matter and one-half decayed vegetable matter. The vegetable matter was in such an advanced state of decay that about one-half of it could be extracted as humus. The muck treated of above was derived from water plants and not from peat moss, and it is difficult to find pure peat in Indiana.

For purposes of comparison samples of muck and pure peat moss in an advanced state of decay were procured in Maine. The muck had been used for a meadow and a hay crop had been removed every year for about 175 years. The mineral matter was about the same in amount as in the Indiana mucks. The peat contained only one and three-quarters per cent. of mineral matter.

Nitrogen in water-free muck and peat from Maine.

Muck soil	1.75 per cent.
Muck subsoil	1.83 per cent.
Peat	0.67 per cent.

The peat contains less nitrogen than average peat from New England.

It will be seen that the dry Indiana muck contains a high per cent. of nitrogen, nearly double the amount of nitrogen contained in the average commercial fertilizer. Many inquiries have been received asking if muck could not be put on the market as a commercial fertilizer. In my opinion it will be found much more suitable for use as an absorbent and an addition to manure. While the nitrogen content of muck is high, the nitrogen is not in a very available form and the fermentation caused by mixing it with manure is the best way of making the nitrogen more available. Commercial fertilizers are usually compounded on the basis of containing much more phosphoric acid than nitrogen. Water free muck seldom contains as much as one per cent. of phosphoric acid and this is not in a very available form. If muck were to be mixed with acid phosphate the fermentation necessary to make the nitrogen available would not take place. If the muck were used alone as a fertilizer it would contain such small quantities of phosphoric acid and potash that it would have to be rated among commercial fertilizers as a very low grade and slowly available nitrogenous goods, and the amount of plant food contained in a ton of it could be purchased in a more concentrated form at less than it would cost to dig, dry, grind and sack the muck.

There is doubtless a good field for the more complete utilization of the great stores of plant food contained in our muck beds, but the muck should be handled on the basis of coarse manure and not as a commercial fertilizer.

MARLS.

By H. A. Huston, W. J. Jones and A. H. Bryan.

The term marl, as usually defined, refers to a mixture of amorphous carbonate of lime with varying proportions of sand and clay. The carbonate of lime is properly the characteristic ingredient. In common usage the word has been applied to very different kinds of material in different sections of the country. Materials which look like marl or occur in beds located like marl, but which contain no carbonate of lime are in some sections called marl. In other places beds of very pure carbonate of lime are found. Ordinary marls should not be confused with the noted green sand marls of New Jersey, which contain notable quantities of phosphoric acid and potash, and, before the advent of commercial fertilizers at reasonable prices, were extensively used as a source of these substances. Even the green sand marl is not of high enough grade to justify shipment to any considerable distance.

The Indiana marls contain high percentage of carbonate of lime. They are practically free from phosphoric acid and contain much less potash than ordinary soil. The marl beds are found under beds of muck, which vary in thickness from a foot to fifteen feet or more. The marl is sometimes mixed with some organic matter of the same general character as the muck.

The agricultural value of the Indiana marls depends on the carbonate of lime present. The nitrogen present seldom exceeds one-half of one per cent. and cannot be considered as available until the marl has been frozen and disintegrated, and the nitrogen changed in form by soil organisms.

Ten Indiana marls showed the following range in composition:

Moisture	0.34	to	0.80	per cent.
Organic matter	3.25	to	6.63	per cent.
Standard insoluble	0.44	to	3.30	per cent.
Carbonate of lime	85.68	to	92.74	per cent.
Magnesia	0.98	to	1.76	per cent.
Sulfur trioxid	0.70	to	1.02	per cent.
Iron and alumina	0.46	to	1.64	per cent.

It will be seen that carbonate of lime is the only ingredient present in large amount. The marls pulverize very readily and their location near much of the light sandy soil of the northern part of the State renders them available for use on these lands.

These light sandy soils are usually deficient in lime and the use of marl on such soil would supply the necessary lime in a non-caustic form and at the same time tend to improve the texture of the soil and make it more retentive of moisture. Since the lime is in such a mild form large quantities, from five to twenty tons per acre can be used without danger of damage to crops. These marls would also prove useful in improving the texture and lime content of heavy clay lands; but it must not be expected to produce such striking effects as much smaller quantities of air slacked lime.

It should be kept in mind that these marls are in no sense complete fertilizers, like stable manure and some kinds of commercial fertilizers. The marls are to be considered from the standpoint of materials to be used at long intervals, an application every seven to ten years, for the purpose of making a somewhat permanent improvement of the land and producing conditions under which the usual manures can be used to better advantage.

We are often asked if these marls cannot be mixed and sold as commercial fertilizers. The large amount required per acre would limit their use to lands near the pits and from what has been said above it will appear that they are in an entirely different class from commercial fertilizers.

Marls of this composition are suitable for the manufacture of cement and if owners of marl deposits wish to exploit them commercially, there is a much better outlook for them in the cement business than in the fertilizer trade. Cement factories would, of course, require large thick beds of fifty acres or more and with as thin over burden as possible, so as to be assured of an abundant supply and a moderate cost of mining. Several large cement factories are now using these marls.

EXAMINATION OF PROTUBERANCES ON SUGAR BEETS.

By H. A. Huston and A. H. Bryan.

During the beet harvest of 1899 a number of sugar beets were found which had one or more protuberances on the upper portion of the roots. Samples of these were selected for examination. The two beets alone weighed 200 grams, and the protuberances removed from them weighed 275 grams.

One-half the material was used for the ordinary analysis of the juice and the other half was carefully dried and used for the determinations usually made in feeding stuffs.

The juice from the protuberances was very dark in color, specific gravity 1.044; contained 7.2 per cent. of sugar, had a purity co-efficient of 65, and it required 1.9 c.c. half normal potash to neutralize 25 c.c. The juice of the beets from which the protuberances were removed, was light in color, specific gravity 1.061, contained 10.6 per cent. sugar, had a purity co-efficient of 70.7, and it required 0.6 c.c. of half normal potash to neutralize 25 c.c.

The normal beets of the same variety in the field were found to contain at this time 15 per cent. sugar with a purity of 87.

This shows that the quality of the beet is very seriously impaired by the protuberances. Examinations made of the crop in 1900 also confirm this.

The food analyses, reduced to water free basis, were as follows:

TABLE XXIV.

Composition of healthy beets and protuberance of beets.

CHEMICAL SUBSTANCES.	Beets.	Protuberances.
Ether extract	1.19	0.85
Crude protein	6.50	14.00
Crude fiber	6.21	7.94
Ash	4.18	7.30
Carbohydrates	81.92	69.91
Total nitrogen	1.04	2.24
Albuminoid nitrogen	.73	1.52
Amid nitrogen	.31	.72
Starch (by diastase)	5.24	2.29
"Carbohydrates" extracted by 1¼% sodium hydrate	2.44	6.40

H. Brien quotes in general terms results of analyses of Strohmer & Stift, which are similar to these so far as relates to protein and ash.

Our analyses show that the crude protein in the roots is lower than we usually find in normal beets, while the protein in the protuberances is higher. The so-called carbohydrates extracted by dilute alkali is probably amoxy or hydro-cellulose. It is included in the carbohydrates in the usual food analysis, but cannot be hydrolized to produce any material that will reduce Fehling's solution. Beets affected with bacterial disease contain it in larger quantity than normal beets.

THE CHEMICAL COMPOSITION OF MATERIALS.

By H. A. Huston and A. H. Bryan.

Alkali incrustation. The Station frequently receives letters relating to supposed alkali lands, located in different parts of the State. The rainfall in all parts of Indiana is too great to permit the existence of what are properly known as alkali lands. In most cases the trouble is generally due to defective drainage. In some instances a white formation is found at the surface. Some of these were examined and found to be caused by a white fungus. One sample from Stillwell, LaPorte County, was examined and found to contain

TABLE XXV

Composition of Alkali incrustation.

Moisture	27.77 per cent.
Volatile and organic matter	20.03 per cent.
Sand and clay	11.93 per cent.
Ferrous oxide	3.94 per cent.
Alumnia	8.49 per cent.
Lime	0.35 per cent.
Magnesia	4.42 per cent.
Sulfur trioxide	23.10 per cent.
Soda	1.70 per cent.

The composition of this material is very different from what constitutes alkali in the arid regions. It is mainly sulfates of iron, alumina, and magnesia. It has a pronounced acid reaction. The iron is practically all in the ferrous condition. The organic and volatile doubtless includes some sulfuric acid driven off in ignition.

This material is then quite different from "alkali" and really is a good illustration of what constitutes one kind of acid soil. The general treatment of this kind of land calls for more thorough under drainage; for local treatment slacked lime should be applied and well mixed with the soil. The lime should be used at the rate of from one-fourth ton to two tons per acre and should be put on the land a month or more before a crop is put in.

Black eye cow pea. The sample of peas was received from Mr. A. F. Diehl of Leesburg.

TABLE XXVI.

Composition black eye cow peas.		
CHEMICAL SUBSTANCES.	Air dry.	Water free.
Moisture	9.56	
Ether extract	2.73	3.01
Crude protein	24.09	26.64
Fiber	2.94	3.25
Ash	4.05	4.48
Carbohydrates	56.63	62.62
Total nitrogen	3.84	4.26
Albuminoid nitrogen	3.57	3.94
Amids	0.27	0.32
Starch (by diastase)	24.70	27.31

The fat, ash and protein are somewhat higher than in analyses quoted from North Carolina and New Jersey for this variety, while the fibre is lower. The starch is much higher than in the soy bean.

Dwarf soy beans. Samples of the beans and of the whole plant were received from Mr. A. F. Diehl of Leesburg. The whole plant was to be used for feeding. Both samples were in excellent condition. The leaves of the forage were green but the pods were white and the beans fairly well ripened.

TABLE XXVII. Composition of soy beans.

	BEANS.		WHOLE PLANT.	
	Air dry.	Water free.	Air dry.	Water free.
Moisture	7.63		7.14	
Ether extract	14.55	15.75	3.07	3.30
Crude protein	35.96	38.93	20.05	21.59
Fiber	4.19	4.53	17.50	18.84
Ash	4.53	4.90	10.53	11.34
Carbohydrates	33.14	35.89	41.71	44.93
Total nitrogen	5.75	6.22	3.20	3.45
Albuminoid nitrogen	4.96	5.33	2.38	2.56
Amid nitrogen	0.79	.89	.82	.89
Starch (by diastase)	9.05	9.70	6.25	6.73

The beans are about the average for soy beans in protein, somewhat below the average in fat and somewhat above the average in carbohydrates. It is to be noted, however ,that only a little over one-fourth of the carbohydrates are in the form of starch.

The whole plant is somewhat higher in fat and a little lower in protein and fibre than the average.

Digestion experiments have shown that the fat and protein of the soy bean are readily digestible.

Examination of water for cooking purposes. A sample of water from Martinsville was sent to the laboratory, with a statement that it was unsatisfactory for domestic purposes, and especially for cooking beans.

The sample was found to contain 102.2 parts solid matter per 100,000 and large amounts of sulfates were present.

Various methods of softening the water were tried and cooking tests made with the resulting products. Parallel tests were made with distilled water and with city water containing about one-third as much solid matter as that from Martinsville. None of the methods of softening the Martinsville water proved effective, and it seems to be a water that is too hard for domestic purposes to admit of any practical improvement at reasonable cost. The amount of water available did not permit of fuller investigation. The total solid matter in the water is over twice as much as is considered admissible in waters for domestic purposes and very much more than is desirable.

Ash of oat clippings and oat dust. At elevators where oats are handled considerable waste in the shape of oat clippings and oat dust is obtained. This is frequently burned and inquiries are received in regard to the value of the ash. The ash from oat clippings obtained at Bourbon was found to contain 4.58 per cent. of potash and 2.50 per cent. of phosphoric acid. The ash from oat dust obtained at Kentland was found to contain 2.90 per cent. of potash and 1.85 per cent. of phosphoric acid. Neither sample contained any soluble phosphoric acid.

The potash in the ash of oat clippings is nearly as great as that found in good quality of wood ash, while the phosphoric acid present is about double the average amount in wood ashes. The ash of the oat dust is not of as good quality as that of the clippings, but it is well worth saving and is worth fully three times as much as leached wood ashes, which are still considered of value in some sections of the country.

Corn cob ash. Considerable quantities of corn cob ash accum-

ulate at elevators and the question of the value of the ash is often raised. It has long been known that this ash is of better quality than wood ashes. In answer to an inquiry from Vincennes we asked that a carefully drawn sample of the unleached ash be sent us.

The analysis showed it to contain of potash 16.03 per cent., and a total phosphoric acid of 5.25 per cent. The phosphoric acid was found to be in three forms, water soluble 2.87 per cent., reverted phosphoric acid 2.28 per cent., insoluble phosphoric acid 0.10 per cent. Heretofore only the total phosphoric acid in this material has been reported and it has been considered as all insoluble and of very little immediate value. The result of our work shows that practically all of the phosphoric acid is in as available form as that contained in the best form of commercial phosphates. Over one-half of it is in the form of phosphate of potash. The high per cent. of potash and the availability of the phosphoric acid in corn cob ash renders it a very valuable fertilizing material. Moreover, it is one of the few crude materials containing water soluble phosphoric acid and at the same time having a marked alkaline reaction. This makes it especially valuable for use on heavy acid clay lands as it would supply phosphoric acid, and potash and at the same time correct the acidity of the soil and materially improve its mechanical condition. It should be applied broadcast, in a finely divided condition and be well harrowed in some time before seeding. On account of the readily soluble state of the potash and part of the phosphoric acid, the acid should be carefully protected from leaching until it is used.

Limestone for sugar beet factory. Five samples of limestone were taken from different levels in a quarry near Shelby, Indiana,

TABLE XXVIII.

Composition of five samples of limestone.

Sample No.	1	2	3	4	5
Insoluble in hydrochloric acid	28.60	45.43	38.31	38.92	45.83
Silica	0.60	0.57	0.59	0.83	0.67
Iron and alumina	1.67	3.85	3.49	2.67	3.96
Lime	22.45	16.60	19.20	18.16	16.60
Magnesia	14.40	9.50	10.74	11.26	9.20

and examined for the purpose of finding out whether they are suitable for use in sugar beet work.

For use in beet sugar factories a fairly pure limestone is desired. These samples contain very high amounts of clay and sand and the large amount of magnesia present shows that the material is more properly an impure dolomite. The magnesia would be objectionable in purifying juices and it would be more profitable to use the pure limestone from the Bedford or Bloomington region. There is also better stone than this in northern Indiana.

Two samples from North Judson showed an improvement in lime content containing 42.04 and 39.34 per cent. of lime. The purest commercial limestones contain from 50 to 55 per cent. lime.

Water of the Kankakee river. In November, 1899, a small sample of Kankakee river water was received with a request to examine it, with a view to determining its suitability for use in sugar beet factory. A qualitative examination showed that the only objectionable matter present in any considerable quantity was sulfate of calcium. The total solid matter was found to be 21.8 parts in 100,000, and of this 10 parts were calcium sulfate. Spencer, in his Handbook for Beet Sugar Chemists, states that water for factory use should not contain over 10 parts of calcium sulfate per 100,000. The total solid matter in this water is much

TABLE XXIX.

Composition of distiller's grain, dried.

	In sample as received per cent.	Water free per cent.
Moisture	7.64	.....
Ether extract	13.52	14.61
Crude protein	31.56	34.17
Fiber	13.40	14.72
Ash	1.71	1.85
Carbohydrates	32.17	34.65
Total nitrogen	5.05	5.46
Albuminoid nitrogen	4.78	5.17
Amid nitrogen	.27	.29
Starch (by diastase)	2.13	2.30
Pentosans	23.17	25.09

less than that in the water used in beet factories in New Mexico, Utah and California. This water is suitable for beet factory purposes and it should be noted that, since the Kankakee was low at the time of taking the sample, the solids are likely to be reduced by rainwater when the river is at a higher stage.

Dried distillers' grain. The sample was received from Aurora, but was made at Lawrenceburg.

This material is of rather better quality than the average for this kind of material. But the product of different distillers is liable to vary considerably on account of the difference in raw materials used. As a feeding stuff the main value of this material is in the protein and fat. Although a little starch is indicated by the diastase method, no reaction for starch could be obtained with iodine.

The material has been subjected to such exhaustive fermentation that only the more resistant carbohydrates remain, and these must be considered far less digestible than starch of ordinary grains.

This class of material is exported to Germany, where it is well liked for production of both meat and dairy products. If it can be purchased at reasonable rates it should be found a very convenient material in compounding rations. It belongs in that group of concentrated feeding stuff represented by gluten meals, but only very few mills make a gluten meal containing as much fat as this sample. See table XX on page 68.

Formaldehyde. In the annual report of last year we gave an account of some tests of the various methods of determining formaldehyde and the formaldehyde content of some commercial samples. Three more samples were examined this year for the Botanical Department. The cyanide method was used:

TABLE XXX.

Formaldehyde tests for strength.

SOURCE.	Formaldehyde per cent. by "volume."	Formaldehyde per cent. weight.
Henry Heil & Co. Bottled	40.8	36.9
Hogan & Johnson. Bulk	40.0	37.0
Eimer & Amend. Bottled	41.9	38.9

There now seems to be little difficulty in obtaining commercial formaldehyde containing 40° by volume, which is probably what the manufacturers mean by a 40 per cent. solution. It would be more exact to express the percentage by weight.

Hominy chop or feed. This sample was drawn at the mill at LaFayette and special care was taken to obtain a representative sample.

It is a side product obtained in the manufacture of hominy or of grits and consists of the germs, the bran and more or less meal. The material may vary considerable, depending on the grades of materials which the manufacturer desires to make. The most conspicuous variation will be in the starch.

TABLE XXXI.

Chemical composition of hominy chop or feed.

CHEMICAL SUBSTANCES.	Per cent.	Water free per cent.
Moisture	8.84	.....
Ether extract	7.63	8.37
Crude protein	11.50	12.94
Fiber	4.12	4.52
Ash	2.62	2.87
Carbohydrates	65.29	71.30
Total nitrogen	1.84	2.07
Albuminoid nitrogen	1.78	1.96
Amid nitrogen	.06	.11
Starch (by diastase)	35.40	38.83

This sample has about the same content of protein and fat as the average of twenty recent analyses made in New England. It is materially higher in both protein and fat than average dent corn. This material bears about the same relation to white corn that bran does to wheat. As compared with bran this material is higher in fat and carbohydrates and lower in protein and fibre.

Feeders state that where hominy chop alone is used cattle are apt to get "off their feed," but that this may be avoided if a mixture of hominy chop and good wheat bran is used.

"Ground oats." A sample of feed sold as ground oats was received from Orleans. The selling price was stated to be $13.50 per ton. It had the following composition:—

TABLE XXXII.

Chemical composition of so-called "ground oats."

CHEMICAL SUBSTANCE.	As received per cent.	Water free per cent.	Average oats water free per cent.
Moisture	6.55	.....	....
Ether extract	2.55	2.73	5.6
Crude protein	5.98	6.40	13.2
Fiber	27.43	29.35	10.8
Ash	6.90	7.50	3.4
Carbohydrates	50.59	54.02	67.0
Total nitrogen	.95	1.02	....
Albuminoid nitrogen	.86	.92	....
Amid nitrogen	.09	.10	....
Starch (by diastase)	16.05	17.17	....

It is evident that the material is not ground oats. It resembles some of the very poorest of the "oat feed" and differs but little from the composition of oat chaff.

The material is too low in fat, protein and real starch to be considered a concentrated feeding stuff and $13.50 spent for whole oats would have procured more than twice as much valuable food ingredients as this material contained. Materials of this class have had an important influence in some States in procuring legislation requiring that commercial cattle feeds shall be sold with a guarantee showing the amount of protein and fat contained in them. Such laws speedily drive inferior goods from the markets of the States where they are in force, and the inferior goods appear in greater quantity in States where the consumer has no protection. Consumers would do well to use great caution in the purchase of commercial feeding stuffs. In discussing oat feeds the Connecticut Experiment Station states that "no feeder can afford to use them, however cheaply he can buy them. They ought not to have a place in the feed market."

Hot house tomatoes.

Two samples of tomatoes grown in the Station hot house were analyzed with the following results:—

TABLE XXXIII

Chemical composition of tomatoes.

VARIETY.	Lorillard.	Stone.
Moisture	94.26	92.83
Solid matter	5.74	7.17
Ether extract	.29	.42
Crude protein	1.27	1.25
Fiber	.50	.68
Ash	.81	.84
Carbohydrates	2.87	3.98
10 per cent. alcohol extract	4.49	5.60
Dextrose in alcohol	1.32	1.85
Sucrose by polariscope	.15	.10
Acids (asmalic)	.44	.57
Dextrose by polariscope	2.16	2.65

The reducing sugars by polariscope were tried on the fresh sample after clarifying with alumina cream. There is noted a discrepancy between the figures obtained by this method and by the gravimetric method employed with the alcoholic solution. It is interesting to note the amount of material extracted by 10 per cent. alcohol. This amount contains the sugars, acids, coloring matter in part and more than likely some of the protein since a larger part of the nitrogen in the tomatoes is not in the form of real albuminoïds, but is in soluble form. The work on these samples was done on samples partially dried at low temperature on steam coils and the drying finished in boiling water oven. There was doubtless some loss of sugar caused by the high temperature used, but the results are comparable with results of the analysis of tomatoes generally published.

SOWING CLOVERS AT DIFFERENT DATES.

By. J. H. Skinner.

In the spring of 1898 series of plats containing one-fortieth of an acre each were laid out for the purpose of testing four varieties of clover sown at different dates. The soil is a compact loam with a gravel sub-soil. The land was in corn the previous year and sown to rye in the fall. The following spring it was plowed, well rolled and pulverized. Just before each sowing the land was cultivated two inches deep with an Albion harrow. After sowing it was run over with a Breed's weeder, and rolled, unless the soil contained too much moisture.

The dates of sowing were April 15, May 15, June 15, July 15, August 15, September 15. Notes on the condition, growth, stand, etc., of the different sowings were taken November 1, 1898, and are as follows:—

April sowing.

Red clover—splendid stand in good condition; four inches high.

Alsike—equally good.

Alfalfa—one-half stand, four to seven inches high; plants yellow and weak.

Crimson clover—one-half stand; plants in bunches, with large vacant spaces.

May sowing.

Red clover—five to seven inches high; splendid stand.

Alsike—four to six inches high, good stand.

Alfalfa—six to eight inches high, one-half stand, plants thrifty.

Crimson clover—one-fifth of a stand; plants healthy.

June sowing.

Red clover—six inches high, good stand.

Alsike—six inches high, good stand.

Alfalfa—10 inches high, good stand, thrifty.

Crimson clover—four inches high, two-thirds of a stand.

July sowing.

Red clover—one-half stand, two inches high, not thrifty.

Alsike—one-third stand, two inches high, thrifty.

Alfalfa—three-fourths stand, three to five inches high, yellow, weakly plants.

Crimson clover—one-half stand, two inches high, healthy.

August sowing.

Red clover—good stand, three inches high, healthy.
Alsike—good stand, three inches high, healthy.
Alfalfa—three-fourths stand, three inches high, healthy.
Crimson clover—three-fourths stand, two to four inches high.

September sowing.

Red clover—good stand, very small.
Alsike—good stand, very small.
Alfalfa—good stand, very small.
Crimson clover—three-fourths stand, very small.

The winter of 1898 and 1899 was a severe one with many sudden changes, which was very injurious to clovers.

The following table shows the yield on the various plats in

TABLE XXXIV.

Dates of cutting and yields of clover.

Date seeding 1899.	Cutting.	Red Clover.	Alsike.	Alfalfa.	Crimson clover.
April 15	First	135 lbs.	145 lbs.	none	none
	Second	75 lbs.	50 lbs.	none	none
May 15	First	125 lbs.	125 lbs.	45 lbs.	none
	Second	62 lbs.	40 lbs.	25 lbs.	none
June 15	First	95 lbs.	120 lbs.	45 lbs.	none
	Second	53 lbs.	30 lbs.	25 lbs.	none
July 15	First	55 lbs.	60lbs.	45 lbs.	none
	Second			50 lbs.	none
August 15	First			105 lbs.	none
	Second	35 lbs.	80 lbs.	25 lbs.	none
September 15	All winter killed.				

Note:—a was one-fifth weeds.
b was two-fifths weeds.
c was one-fifteenth weeds.

The table above shows that the red clover made the best yield for the April sowing with a gradual decrease for each successive sowing until that of September 15, which had been frozen out completely. The alsike gives a similar record with the exception of the July sowing, which made less than that for August. This was probably due to the fact that there was a poor stand, as is shown by the notes above. Alfalfa shows very different results.

The April and May sowings were frozen out entirely. The June sowing gave a small yield and had many weeds in it; the July sowing a slight increase over that sown in June, with many weeds; while the August sowing made very much the largest yield and was free of weeds. The entire failure of the April and May sowings of alfalfa and a gradual increase in yield for the successive sowings is probably due to three conditions:—the weather at the time of sowing and after; the lack of care in neglecting to mow and keep the weeds down; then the freezing and thawing broke a larger number of roots and heaved many more plants in the early sowings. Only a few plants in the August sowing were severely injured by freezing, as the roots were just deep enough to hold fast to the upper layer of soil, raising and settling as the soil did without breaking the roots. The crimson clover was a complete failure, not a single plant coming through the winter alive.

This work was taken up again in the spring of 1899. The season was a very unfavorable one, and insects, such as grasshoppers, squash bugs and potato bugs, aided it in destroying the young plants, so that the whole season's work was a failure.

Summary.

1. Where the season is favorable, red and alsike clover may be sown as late as June 15, with a reasonable assurance of getting a stand.

2. It is more difficult to get a stand of alfalfa than either of the above.

3. Alfalfa requires that the seed bed be more carefully prepared than that for red or alsike clover.

4. Alfalfa cannot stand choking by weeds. For this reason sow on clean land.

5. The plants themselves must be clipped with a mower about once a month.

6. Alfalfa is easily winter killed the first year, as many of the roots are broken by the lifting, due to freezing.

7. It was found by leaving these clovers stand through a second winter that nearly all the red and alsike were killed, while the alfalfa came through the second winter very much stronger than it did the first, with but few plants injured.

8. It is very hard to get a stand of crimson clover.

9. Crimson clover will not live through a severe winter unprotected.

FORAGE CROPS.

By J. H. Skinner.

The annual report of 1899 gives a complete account of the work done at Purdue on forage crops up to that time.

It was with the purpose of getting more data as to the comparative yields of different crops, also to learn what rate of seed gave best results, that the work was again taken up.

The plats contained 1-18 acres each. Two were sown with the same variety of seed; one drilled in rows eight inches apart, the other 16 inches apart. The land was plowed seven inches deep May 25, and rolled down firmly and thoroughly pulverized. Just before sowing a plank drag was run over it, leaving a very superior seed bed with a smooth surface.

The various crops were sown May 26 with a Crown drill, the drill being set to sow one bushel where the rows were eight inches apart and two bushels where 16 inches apart.

The season was a favorable one. With the exception of the first part of June, the rainfall was sufficient and well distributed. The crop was cultivated with a Breed's weeder June 12, in order to break a crust which had formed on the surface of the soil. This was the only cultivation given, as the soil was in good condition and free from weeds. Care must be taken in the use of the weeder or the injury to the plants will be far greater than the benefit. They can be cultivated with a weeder when from four to eight inches high, if it be done when they are free of moisture, that is in the heat of the day. If cultivated when smaller many plants are destroyed by being broken off and the same is true where they are very much larger.

Cow peas.

Only two varieties were used, as we were unable to procure seed enough for as large plats as we desired.

Whip-poor-will. This variety is a thrifty grower and one of the earlier ones. It produces long vines, which trail on the ground.

The plat where the rows were 16 inches apart, was cut for seed and gave a yield of 18 bushels per acre, while the plat having rows eight inches apart was cut and put in the silo. Yield of green forage four tons. Considerable loss, which could not be estimated, would raise the yield in both cases.

Black. This variety is a vigorous grower, making more vine and less grain than the Whip-poor-will. It is also several days later. Yield of forage from four to 4.5 tons per acre.

Note:—It was easily seen that where the rows were 16 inches apart the yield of beans was greater, while the yield of forage was less, than where they were eight inches apart.

Soy beans.

The soy beans showed just the reverse of what occurred with the cow peas, that is, that soys produced more beans and less forage where sown eight inches apart.

The soy bean grows upright and is much more easily handled and harvested than the cow pea.

Kysuke is a dwarf which makes a better yield of grain than forage. It is early and a vigorous grower. The estimated yield of forage is 2.5 to three tons; grain, 15 bushels.

Black, This variety did not germinate well, so no comparison as to yield is possible. The few that grew made a large yield of forage and small yield of grain. It is a late variety.

Medium green is a very promising variety which grows three to four feet high on this soil. The leaves are large and would make splendid hay. This variety made from four to 4.5 tons green forage and 16 to 18 bushels grain where harvested. The beans must be cut before ripe, or they will shell out badly.

Sorghums.

The sorghum was too thick in both wide and narrow rows, and lodged badly on this account. Where the rows were eight inches apart it was not so coarse as that where the rows were 16 inches apart. The difference in the yield on the different plats was not very great, but the variation in yield of different varieties was marked, as the following table shows:—

TABLE XXXV.

Yield of sorghum.

VARIETY.	Rows eight inches apart.		Rows sixteen inches apart.	
	Per plat.	Per acre.	Per plat.	Per acre.
Coleman's	2540 lbs.	22.8 tons	2255 lbs.	20.3 tons
Folger's early........	1650 lbs.	14.9 tons	1615 lbs.	14.5 tons
Early amber.........	1660 lbs.	14.9 tons	1785 lbs.	16.[illegible] tons
Early Orange........	1550 lbs.	13.9 tons	1530 lbs.	13.7 tons

The above table shows with one exception, a greater yield for the rows eight inches apart.

Corn.

Common field corn and Stowell's Evergreen were the only varieties used. Both grew well. The field corn made a larger yield but was two or three weeks later than the Evergreen, which was ready to use by the last of July. The corn was not cut for green forage, so only an estimate of the yield could be gotten. The corn grew better and made a much better yield where drill was set to sow one bushel per acre in rows eight inches apart. The yield is estimated at seven to eight tons for the Evergreen and 10 tons for common corn.

The work done indicates that so far as yield is concerned, sorghum stands at the head, common corn second and Stowell's Evergreen third.

The cow pea and soy bean make a small yield as compared with the other crops grown, and live stock must be educated to eat cow peas and soy beans.

Only the earlier varieties of cow peas can be depended on for a grain crop in this latitude, as the later ones do not ripen before the early frosts.

Soy beans may be made a profitable grain crop on the proper kind of soil.

The cow pea and soy bean both make good hay, but are very difficult to cure in this section.

Cow peas and soy beans make a splendid green manuring crop and may be a valuable substitute for clover that has been winter killed.

AN IMPROVED COW STALL.

By H. E. Van Norman.

The ideal cow stall should have among other requisites, the following: a fastener that will hold the animal securely, be easy to fasten when securing the animal and to unfasten when turning it out. The fastener should be so arranged that there is no danger of the animal getting the feet caught in it, and should give the maximum of liberty commensurate with cleanliness.

The stall should be so constructed as to keep the animal clean and to absolutely prevent any possibility of one animal injuring another, either by stepping on the udder or by hooking, also prevent one from frightening another by being able to almost reach it.

The manger should hold the necessary feed and roughage, keeping it within reach of the animal, preventing it being gotten under foot and should be easily cleaned of all refuse matter. Often the owner of a herd of cattle desires a stall that will expose to the visitor's view as much of each animal as possible without lessening the security to his animals.

A stall should be inexpensive and strong.

The following is a description of a stall which has given excellent satisfaction in over a year's service in the Station cow barn, and possessing the above mentioned features. Fig 2 represents the arrangement for two rows of stalls facing each other

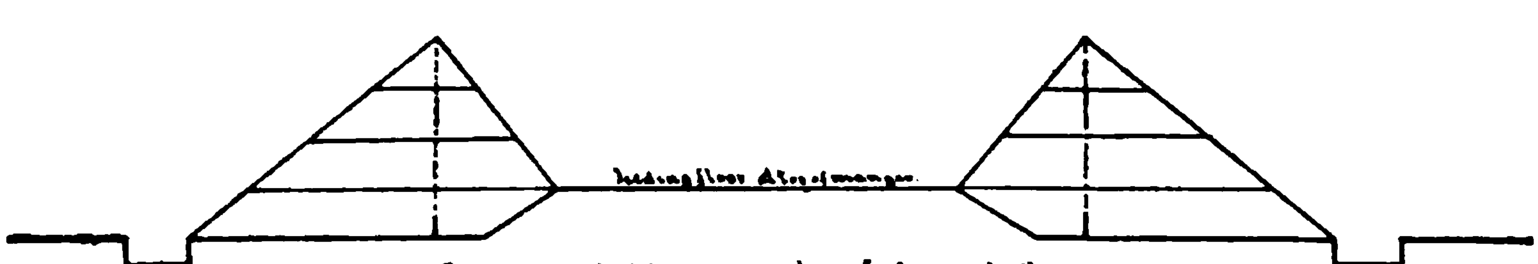


Fig. 2.

with the feeding alley raised to the top of the manger, allowing feed and hay to be swept into the manger and refuse to be swept out of the manger into the alley for removal. The stall may be constructed of 2-inch lumber, dressed on two sides, or if to be white-washed 1½-inch stuff, rough, will hold the white-wash better than if smooth. These are standard sizes of lumber, but 1½ dressed and 1¼ rough are strong enough. For dairy cows of average size stalls, 3 feet 6-inch from center to center and five

feet from gutter to manger will be about right. The animal should have just room to stand comfortably with hind feet an inch from the gutter and front feet just back of A in Fig 3. A

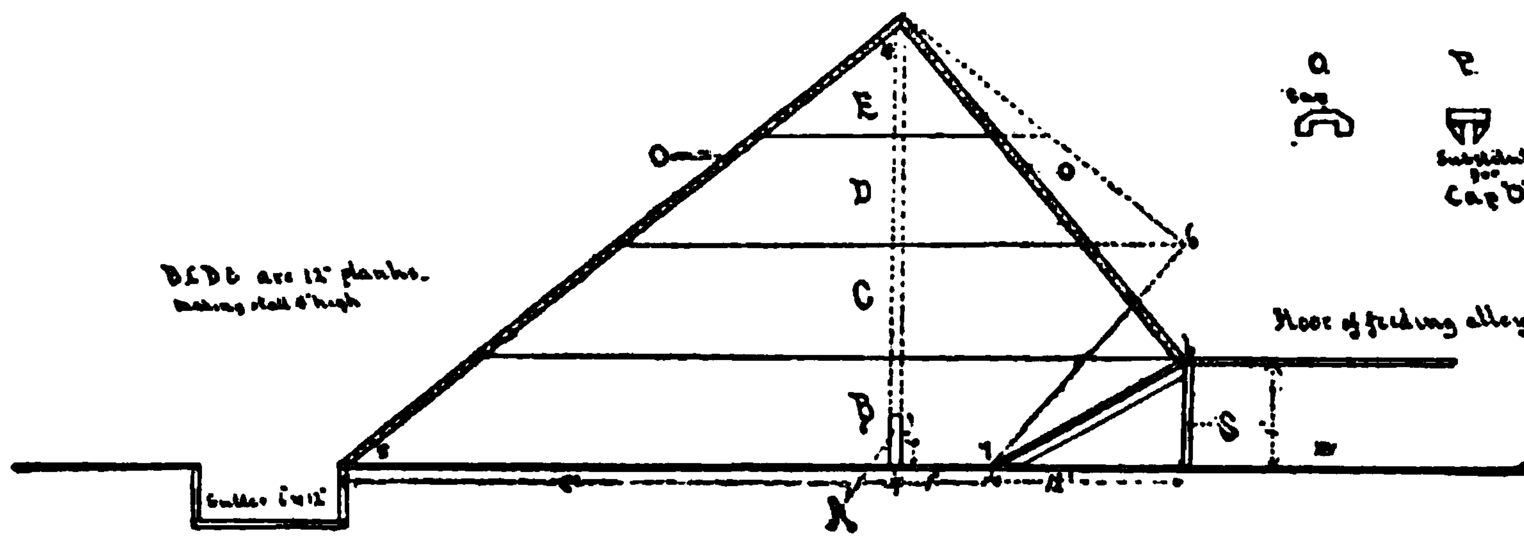


Fig. 8.

desirable arangement is to place the timber A five feet from the gutter at one end of the barn and enough closer at the other end to fit the smallest animal, thus giving the stalls varied lengths.

To build the stall. Place the 2x6 A (Fig. 3) in position five

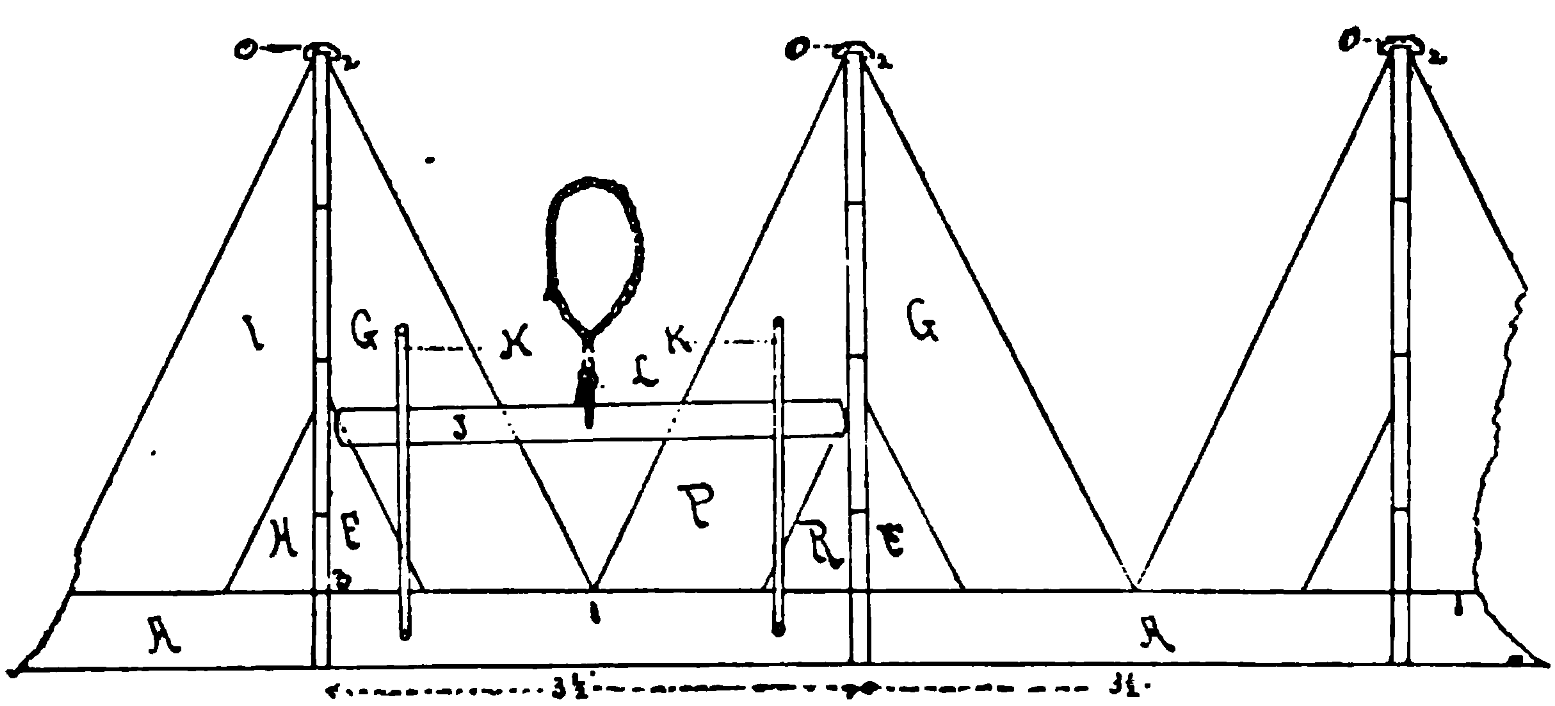


Fig. 4.

feet or less from the gutter, then the raised feeding floor should be built with the joist S $2\frac{1}{2}$ feet in the clear from A; then cut the plank B and fasten in place, and successively planks C, D and E,

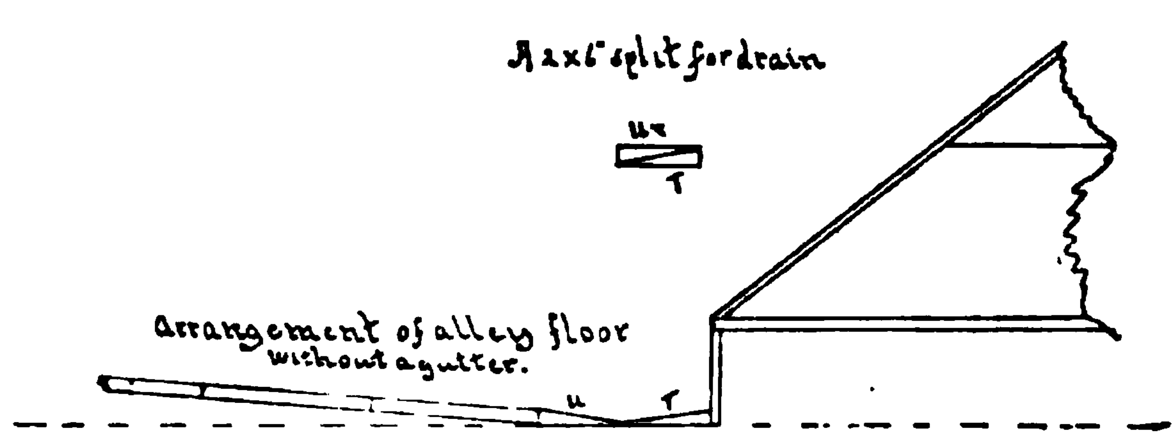


Fig. 5.

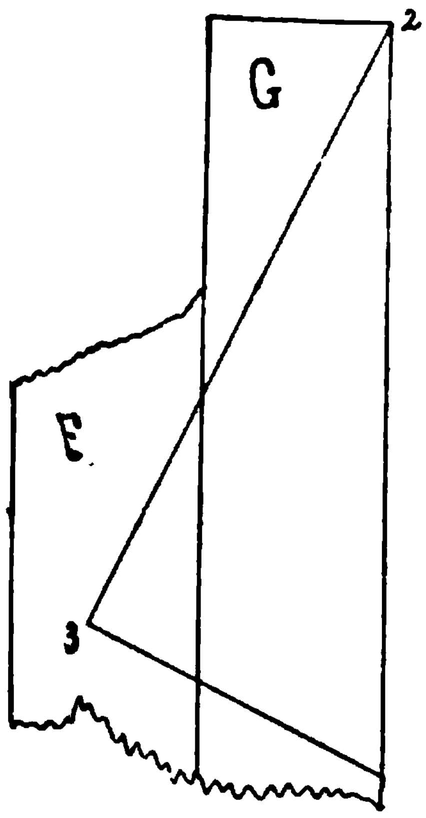


Fig. 6.

holding them temporarily with a cleat until F and G are secured. To cut F and G, lay two pieces of plank on the floor, and on the one G (Fig. 6) lay off the distance 1 to 2 along the edge equal to the distance from the top of partition 2, (Fig. 4) to middle of manger on top of A at 1, fig. 4, then mark off 2-3 and 3-1, making the corner at 3 exactly square. It will make little difference if planks G and P, fig. 4, do not touch at 1. When properly fitted toe nail G to A at 1, and nail B. C. D and E to F and G; then toe nail H and I in place. The partition between stalls is now held securely in place and the operation may be repeated for as many stalls as wanted.

It is well to leave the planks B, C. D. E a little long, or even square and when in position draw lines from 4 to 5 and 4 to 6, fig. 3, and saw off along these lines. The ends of the planks B, C, D and E should be covered with a partition capO, fig. 3, which holds them in place and gives a finished appearance to the stalls. In the absence of the capping O, strips as shown at P, fig. 3, may be used.

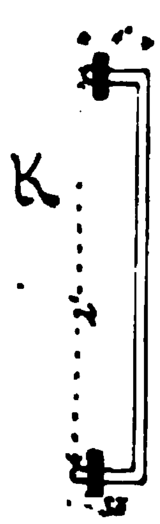


Fig. 7

The bar J, fig. 4, should be one inch shorter than the distance between partitions and made of 1x3 light, strong wood, round corners and slides behind iron staples. K, figs. 4 and 7, which are made of ½-inch round iron, with nuts on the end or with a hole and key. These staples K should be placed nine inches from the partition and lower end near the floor.

In the middle of J place a clevis of 1x1-8-inch strap iron, in which to fasten a common chain tie. Bore hole for clevis bolt just above the middle of bar. This bar should hang far enough from the neck to allow the cow to stand comfortably with the head in a natural position.

Where conditions make the feeding alley impracticable the front of the manger may be arranged on the plan of the dotted lines in fig. 3. If desired a 2x2-inch piece may be run along on top of the stalls at 2, fig. 4, though it is not recommended.

It has been suggested that instead of the gutter, a drop be arranged, as shown in Fig. 5. T and U are made of a 2x6, split diagonally.

APPENDIX.

GIFTS have been made the Station from time to time, and acknowledgment is herewith made to the friends of the Station for these favors, with thanks for the same. The following have been received from

The Hart Pioneer Nurseries, Ft. Scott, Kan. 10 tree protectors.

S. W. Rarick, Markle, Ind. Peck Winter King wheat.

C. E. Stubbs, Secretary, Fairfield, Iowa. Vols. 4, 5, 6 of the National Register of French Draft Horses.

Frederick L. Hougton, Secy., Brattleboro, N. H. Vol. 16 Holstein-Friesian Herd Book.

C. R. Thomas, Secy., Independence, Mo. Vols. 20 and 21 American Hereford Record.

L. B. Baker Mfg. Co., Racine Junction, Wis. Patent sheep collar.

N. B. Deatherage, Richmond, Ky. Peck Swamp wheat.

A. V. Bradrick, Secy., Shelbyville, Ind. Vol. 9 American Duroc-Jersey Record.

A. J. Temple, Secy., Cameron, Ill. Vol. 2 American Leicester Record.

W. H. Morris, Secy., Indianapolis, Ind. Vol. 7 Standard Chester White Record ..

H. M. Stringfellow, Galveston. Tex. "The New Horticulture."

Mortimer Levering, Secy., LaFayette, Ind. Vols. 12 and 13 American Shropshire Sheep Record.

William E. Henry, State Librarian, Indianapolis. Legislative and State Manual of Indiana for 1899 and 1900.

Hon. John Dryden, Minister of Agriculture, Ottawa, Ontario, Can. Reports Ontario Department of Agriculture.

Diamond Crystal Salt Co., St. Clair, Mich. 1 barrel salt.

F. Barteldes, Lawrence, Kansas. Seed.

Crown Mfg. Co., Phelps, N. Y. Repairs to Crown Drill.

Gale Mfg. Co., Albion, Mich. Repairs Albion Cultivator.

W. A. Shafor, Secy., Middletown, Ohio. Vol. 7 American Oxford Down Record.

Hillis & Shoptaugh, Greencastle, Ind. One dust sprayer.

German Kali Works ,New York City. German potash salts and various publications.

Isaac A. Smith, Warren, Ind. Peck of oats.

S. J. Lehman & Co., Enon, Ohio. Seedling strawberry plants.

M. Matthewson, Berryton, Kan. Package Kaffir corn.

DeLaval Separator Co., Chicago, Ill. Repair to separator.

Rossville Distillery Co., Lawrenceburg, Ind. Ton distillery dried grains.

John Deming, Brewersville, Ind. Winter oat seed.

United States Department of Agriculture, Washington, D. C. Numerous scientific periodicals, books and seed.

AGRICULTURAL PERIODICALS.

The publishers of the following periodicals have generously sent them free to the Station during the year. These are leading journals and are used frequently by all persons coming in contact with our library.

American Agriculturist	New York, N. Y.
Agricultural Epitomist	Indianapolis, Ind.
American Creamery	Chicago, Ill.
American Gardening	New York, N. Y.
American Grange Bulletin	Cincinnati, Ohio.
American Horticulturist	Wichita, Kansas.
American Sheep Breeder and Wool Grower	Chicago, Ill.
American Swineherd	Chicago, Ill.
Baltimore Sun (weekly)	Baltimore, Md.
Beet Sugar Gazette	Chicago, Ill.
Breeders' Gazette	Chicago, Ill.
California Cultivator	Los Angeles, Cal.
Chicago Dairy Produce	Chicago, Ill.
Colman's Rural World	St. Louis, Mo.
Creamery Gazette	Des Moines, Iowa.
Creamery Journal	Waterloo, Iowa.
Dairy and Creamery	Chicago, Ill.
Dakota Field and Farm	Sioux Falls, S. D.
Drainage Journal	Indianapolis, Ind.
Drovers' Journal	Chicago, Ill.
Elgin Dairy Report	Elgin, Iowa.
Experiment Station Record	Washington, D. C.
Farm and Dairy	Ames, Iowa.
Farm and Fireside	Springfield, Ohio.
Farm and Home	Chicago, Ill.
Farm, Field and Fireside	Chicago, Ill.
Farm Journal	Philadelphia, Pa.
Farm Poultry	Boston, Mass.
Farmers' Call	Quincy, Ill.
Farmers' Guide	Huntington, Ind.
Farmers' Home	Dayton, Ohio.
Farmers' Review	Chicago, Ill.
Farmers' Tribune	Des Moines, Iowa.
Farmers' Voice	Chicago, Ill.
Feather, The	Washington, D. C.
Field and Farm	Denver, Colo.
Gazette (weekly)	Cincinnati, Ohio.
Golden Egg	St. Louis, Mo.
Grange Visitor	Lansing, Mich.
Home and Farm	Louisville, Ky.
Hospedarska Listy	Chicago, Ill.
Indiana Farmer	Indianapolis, Ind.
Iowa Homestead	Des Moines, Iowa.
Jersey Hustler	Lebanon, Ohio.
Journal of Agriculture	St. Louis, Mo.

Kansas Farmer...Topeka, Kansas.
Live Stock Journal...Chicago, Ill.
Louisiana Planter...New Orleans, La.
Market Garden...Minneapolis, Minn.
Mirror and Farmer...Manchester, N. H.
Montana Fruit Grower...Missoula, Mont.
National Farmer and Stock Grower...........National Stock Yards, Ill.
National Stockman and Farmer...Pittsburg, Pa.
Nebraska Farmer...Lincoln, Neb.
New England Farmer...Boston, Mass.
New York Produce Review...New York, N. Y.
Oregon Agriculturist...Portland, Ore.
Our Horticultural Visitor........Kinmundy, Ill., Benton Harbor, Mich.
Pacific Homestead...Salem, Ore.
Pacific Rural Press...San Francisco, Cali.
Practical Dairyman...Indianapolis, Ind.
Practical Farmer...Philadelphia, Pa.
Prairie Farmer...Chicago, Ill.
Public Ledger (daily)...Philadelphia, Pa.
Reliable Poultry Journal...Quincy, Ill.
Rural Northwest...Portland, Oregon.
Southern Farm Magazine...Baltimore, Md.
Southern Planter...Richmond, Va.
Southern States...Baltimore, Md.
St. Paul Dairy Report...St. Paul, Minn.
Success with Flowers...West Grove, Pa.
Sugar Beet...Philadelphia, Pa.
Swine Breeders' Journal...Indianapolis, Ind.
Tippecanoe Farmer...LaFayette, Ind.
Up to Date Farming...Indianapolis, Ind.
Wallace's Farmer...Des Moines, Iowa.
Western Creamery...San Francisco, Cal.
Western Fruit Grower...St. Joseph, Mo.
Western Horseman...Indianapolis, Ind.
West Virginia Farm Review...Charleston, W. Va.
Wisconsin Agriculturist...Racine, Wis.

INDIANA PERIODICALS.

Advertiser ....Medaryville.
American Standard...Frankfort.
Banner ....Bluffton.
Columbia City Mail...Columbia City.
Democrat ....Salem
Home Journal...LaFayette.
Hoosier State...Newport.
LaFayette Commercial Gazette...LaFayette.
Lyons' Herald...Lyons.
Magnet ....Angola.
Mennonitische Rundschau...Elkhart.

News .... Monon.
Recorder .... Rising Sun.
Register .... Crown Point.
Silent Hoosier .... Indianapolis.

FOREIGN.

Agricultural Gazette of New South Wales .... Sidney, Australia.
Co-Operative Farming .... Sussex, N. B.
Farmers' Advocate .... London, Ontario.
Farming .... Toronto, Canada.
Queensland Agricultural Journal .... Brisbane, Australia.

Besides the above, the following periodicals are on file in the Station library as regular subscription journals:

American Veterinary Review .... New York, N. Y.
Berichte der Deutschen Botanischen Gessellschaft ...... Berlin, Germany.
Botanisches Centralblatt .... Cassel-Marburg, Germany.
Botanische Zeitung .... Leipsig, Germany.
Bulletin de la Societe Chemique de Paris .... Paris, France.
Centrallblatt fur Bakteriologie .... Jena, Germany.
The Entomologist .... London, England.
Gardeners' Chronicle .... London, England.
Journal fur Landwirthschaft .... Berlin, Germany.
Journal of Comparative Medicine .... Philadelphia, Pa.
Journal of the Royal Agricultural Society of England .. London, England.
Journal of the Chemical Society .... London, England.
Live Stock Journal, The .... London, England.
Veterinary Journal, The .... London, England.
Veterinarian, The .... London, England.
Zentschroft fur Analytische Chemie .... Weisbaden, Germany.

TREASURERS' REPORT EXPERIMENT STATION.

As Treasurer of Purdue University, I hereby submit my report of all moneys received during the year ending June 30, 1900, on account of Experiment Station funds:

From United States Government	$15,000.00
From farm receipts	1,836.63
Total	$16,836.63

JAMES M. FOWLER,
Treasurer Purdue University.

FINANCIAL STATEMENT.

The Agricultural Experiment Station of Indiana, in account with the United States for the year ending June 30, 1900.

DEBIT.

Received of the Treasurer of the United, receipts as shown by the Treasurer's resport..............$15,000.00

CREDIT.

Salaries	$ 8,637.70	
Labor	2,717.19	
Publications	731.35	
Postage and stationery...............	77.09	
Freight and express..................	80.14	
Heat, light and water................	526.85	
Chemical supplies	219.59	
Seeds,, plants and sundry supplies......	705.01	
Fertilizers	8.55	
Feeding stuffs.......................	527.60	
Library	93.92	
Tools, implements and machinery......	422.11	
Furniture and fixtures................	68.30	
Scientific apparatus..................	37.90	
Live stock...........................	53.10	
Traveling expenses...................	40.85	
Contingent expenses..................	4.13	
Buildings and repairs................	148.62	
Total.....................	$15,000.00	$15,000.00

I hereby certify that the above is correct statement of expenditures in the Station Fund for the year ending June 30, 1900.

E. A. ELLSWORTH,
Secretary of Board of Trustees.

IMPROVEMENT FUND EXPERIMENT FARM FOR YEAR ENDING JUNE 30, 1900.

DEBIT.

Balance June 30, 1899		$ 414.58
Receipts from farm for year ending June 30, 1900		1,836.63

CREDIT.

Salaries	$ 919.14	
Labor	495.14	
Heat, light and water	14.18	
Feeding stuffs	57.30	
Live stock	40.00	
Contingent expenses	259.30	
Buildings and repairs	32.85	
Balance	433.30	
Total	$2,251.21	$2,251.21

I hereby certify that the above is a correct statement of expeditures from the Improvement Fund for the year ending June 30, 1900.

E. A. ELLSWORTH,
Secretary of Board of Trustees.

ERRATA.

Page 12, line 19 from bottom, "roots" should read *shoots*.

Page 20, last line, "II" should read *III*.

Page 27, sixth line from top, "grain" should read *gram*.

Page 35, between eighth and ninth lines from bottom, insert, *whole fruit was affected and gave off the same offensive odor. On March 22 the two.* Strike out the word "whole" commencing line eight.

Page 71, table XXIII, transpose 2.88 and 3.39.

Page 79, line seven, "amoxy" should read *an oxy*.

Page 80, table XXIV, "alumnia" should read *alumina*.

Page 85, sixth line above table, "See table XX on page 68" should read *see table XXIX, page 84*.

Page 90, table XXXIV. The figures 35 lbs. under Red Clover, and 80 lbs. under Alsike, should be raised one line to represent the first cutting.

Page 90, foot note under table. The letters refer to the following cuttings:

a. First 55 lbs. red clover.
b. First 35 lbs. red clover.
c. First 145 lbs. alsike.

Page 103, in Financial Statement, "Heat, light and water..526.85." should read *$426.85*.

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PURDUE UNIVERSITY

Fourteenth Annual Report

OF THE

Indiana Agricultural Experiment Station

LAFAYETTE, INDIANA

For the year ending June 30, 1901

PURDUE UNIVERSITY

Fourteenth Annual Report

OF THE

Indiana Agricultural Experiment Station

LAFAYETTE, INDIANA

For the year ending June 30, 1901

To the Governor:

I transmit herewith the annual report of the Purdue University Agricultural Experiment Station for the year ending June 30, 1901.

WILLIAM V. STUART,
President of the Board of Trustees.

November 21, 1901.

To the President of the Board of Trustees:

I herewith present the fourteenth annual report of the Agricultural Experiment Station of Indiana for the year ending June 30, 1901, the same being required by Section 3, of an act entitled "An act to establish agricultural experiment stations in connection with the colleges established in the several States, under provisions of an act approved July, 1862, and of the acts supplemental thereto," and being in accordance also with the instructions of the Department of Agriculture.

This report consists of a report of the Director of the Station, a number of contributions on station investigations by members of the Staff, and a financial report of the Secretary to the Board of Trustees.

WINTHROP E. STONE,
President.

November 21, 1901.

BOARD OF CONTROL.

William V. Stuart, President......LaFayette, Tippecanoe Co.
William A. Banks....................LaPorte, LaPorte Co.
Sylvester Johnson....................Irvington, Marion Co.
David E. Beem........................Spencer, Owen Co.
Job H. VanNatta.................LaFayette, Tippecanoe Co.
Benjamin Harrison*................Indianapolis, Marion Co.
William H. O'Brien............Lawrenceburg, Dearborn Co.
James M. Barrett....................Fort Wayne, Allen Co.
Charles Downing..................Greenfield, Hancock Co.
Charles B. Stemen....................Fort Wayne, Allen Co.

Edward A. Ellsworth, Secretary.
James M. Fowler, Treasurer.

STATION STAFF.

Winthrop E. Stone, A. M., Ph. D.,President of the University.

Charles S. Plumb, B. S.............................Director
William C. Latta, M. S........................Agriculturist.
James Troop, M. S..........................Horticulturist.
Henry A. Huston, A. M., A. C.......................Chemist.
Joseph C. Arthur, D. Sc..........................Botanist.
Arvill W. Bitting, M. D., D. V. M.............Veterinarian.
William Stuart, M. S......................Asistant Botanist.
A. Hugh Bryan, B. S., A. C.**..............Asistant Chemist.
John Harrison Skinner, B. S............Asistant Agriculturist.
H. E. VanNorman, B. S....Farm Superintendent and Assistant.

*Died March 13, 1901.
**Resigned Jan. 1, 1901.

TABLE OF CONTENTS.

FOURTEENTH ANNUAL REPORT

OF THE

Purdue University Agricultural Experiment Station.

FOR THE YEAR ENDING JUNE 30, 1901.

REPORT OF THE DIRECTOR.

To President W. E. Stone:

Sir:—I herewith submit the fourteenth annual report of this Station, for the year ending June 30, 1901.

The work of the Station has continued along the same general lines up to the end of this year. In the Chemical Department attention has been chiefly given to sugar beet tests, soil work, and a limited amount of miscellaneous determinations. The field plats have remained as for some years past, with no important change in the work of the Agriculturist. In the Botanical Department there has been a concentration, and less field work has been attempted, but considerable more pot and greenhouse work has been in progress than usual. The Veterinarian gives one-half his time to the Station, and during the past year this has been largely given up to a study of farm sanitation and the source and character of city milk. As the Veterinarian has also acted as Milk and Meat Inspector for the City of LaFayette, it has given him unusual facilities for studying the subject of city milk. Some attention has also been given to the subjects of hog cholera and sheep scab. The Horticultural Department work has continued in the same field, with no special investigations of interest. The Live Stock Department has continued

its work in feeding swine, and in a limited way in cross breeding. Some feeding experiments on farm horses were also inaugurated.

The Station Staff has undergone one change, in the resignation of Mr. Bryan, the Assistant Chemist, who severed his relations with the Station on January 1, in order to take up commercial work. Thus far this vacancy has not been filled.

In connection with the subjects of the Station work, and the working force, certain changes have been adopted by the Board of Trustees, which I believe will much add to the general efficiency of this Station. This involves a division of the work in the Horticultural Department, and after September 1 next, Professor Troop will devote his attention to the tree and small fruits, while Mr. Stuart, at present Assistant Botanist, will be promoted to the new position of Associate Horticulturist, and will give his entire attention to Vegetable gardening work. Mr. VanNorman, who has for this year acted as an assistant of the Director, will on September 1 assume the position of Dairyman, and give his entire time to that subject, relieving the writer of all dairy work. The vacancy caused by Mr. Stuart in the Botanical Department will be filled by Mr. Herman B. Dorner, beginning September 1. On this same date Professor Latta will sever his active relationship to the Station as Agriculturist, and Professor F. S. Johnston will take up the field and crop work, at first as Associate Agriculturist. Professor Latta has for about eighteen years had charge of the experimental field plats at Purdue, during which time much careful, valuable and systematic work has been prosecuted under his direction. The increase in his work as Superintendent of Farmers' Institutes has made it seem necessary to cause this severance of relations with the Station. The general changes contemplated, however, for next year, it is believed will add materially to the results secured by the Station.

The Station Mailing List has been revised this year. It had assumed large proportions, and the ordinary editions of bulletins were 20,000 copies. Hundreds of names were on this list that had been on it for years, and from whom no acknowledgments had ever been received. An addressed private mailing card was accordingly sent out to each person on the list, informing him that the list would be revised, and requesting an acknowledgment if future bulletins were desired.

On June 30, 1901, the new list consisted as follows:

Names of persons in Indiana	5,694
" " " " other states	1,077
" " " " British America	35
" " " " other foreign countries	29
Indiana periodicals	621
Periodicals outside of Indiana	119
Total	7,575

Publications have been issued during the year as follows:

PAMPHLET BULLETINS.

Bulletin No. 83. Vol. X, August, 1900, pp. 107-114. Tests of small fruits. By James Troop, Horticulturist.

Bulletin No. 84, Vol. X, September, 1900, pp. 115-142. Growing lettuce with chemical fertilizers. By William Stuart, Assistant Botanist.

Bulletin No. 85, Vol. X, October, 1900, pp. 143-150. Chrysanthemum rust. By J. C. Arthur, Botanist.

Bulletin No. 86, Vol. X, December, 1900, pp. 151-158. On the amount of water in slop fed fattening pigs. By C. S. Plumb, Director, and H. E. VanNorman, Assistant.

Bulletin No. 87, Vol. XI, March, 1901, pp. 26. Formalin as a preventive of oat smut. By William Stuart, Assistant Botanist.

Bulletin No. 88, Vol. XI, May, 1901, pp. 27-38. Systems of cropping with and without fertilization. By W. C. Latta, Agriculturist and J. H. Skinner, Assistant.

NEWSPAPER BULLETINS.

No. 86, July 19, 1900. The Hessian Fly (*Cecidomyia destructor*) By James Troop, Horticulturist.

No. 87, August 1, 1900. Shall Indiana farmers continue to grow wheat? By W. C. Latta, Agriculturist.

No. 88, October 6, 1900. Influenza of cattle and sheep. By A. W. Bitting, D. V. M., Veterinarian.

No. 89, November 30, 1900, Sugar Beet Experiments in Indiana. By C. S. Plumb, Director.

No. 90, February 27, 1901, Black knot of the plum and cherry. By James Troop, Horticulturist.

No. 91, March 27, 1901, Rape and its cultivation. By J. H. Skinner, Assistant Agriculturist.

ANNUAL REPORT.

Thirteenth Annual Report of the Indiana Agricultural Ex-

periment Station, Lafayette, Indiana, for the year ending June 30, 1900, pp. 104, Plate I, figs. 6.

The State appropriation for a new Hall for the School of Agriculture at Purdue University, will be the means of adding materially to the accommodations of the Experiment Station. The class rooms now in the Experiment Station building will be abandoned on the occupancy of the new structure, and thus the Station will come into the use of valuable room.

There are several rather important improvements that are desirable for the future, as affecting the interests of this Station. Most important of these, is the desirability of a sub-station in southern Indiana, where experiments on soils and soil fertility may be undertaken. The home station atLaFayette is located on a soil of superior natural surface fertility, but underlaid deeply with a very porous gravel. It is not suited to certain experimental work, and in times of drouth our crops suffer severely. Further, while the use of commercial fertilizers in the State is constantly increasing, the station has no land subject to its control where experiments may be conducted with crops and fertilizers under satisfactory or suitable conditions. Southern Indiana uses large amounts of fertilizer, and a sub-station in that section of the State, would offer a valuable opportunity for the Station to carry on investigations of importance, at present quite impossible with the limited funds at our command. An appropriation by the State seems a necessity if such a sub-station is to be a possibility. Some years ago some co-operation experiments were undertaken in Orange and Munroe counties, but the conditions were not as satisfactory as they would have been if the work had been on land controlled by the Station. This is a subject worthy careful consideration for the future.

For years this Station has conducted research work on edible mushrooms. About 1895 a mushroom cellar was constructed of planks covered with soil. Here edible mushrooms were grown and important work undertaken. This cellar, however, was made of old planks and this winter the roof completely caved in and the cellar was ruined. The subject of edible mushrooms is an important one, as much valuable work, quite new in character, may be conducted in this special field. In view of this it is desirable that a new brick modern mushroom cellar be constructed at this Station, that this work may be prosecuted. Plans are already drawn for such a structure, which will cost approximately \$500 to \$600.

Respectfully submitted,

C. S. PLUMB,
Director.

TWO WEEDS: HORSE NETTLE AND BUFFALO BUR.

By J. C. Arthur.

Some weeds are harmless vagrants, others are insidious usurpers; the one kind is unsightly but easily overcome, the other requires vigorous and persistent onslaught. Of the latter sort are the two comparatively infrequent visitors on Indiana farms, the horse nettle and the buffalo bur. It is because these weeds are decidedly noxious, aggressive, and very properly attracting more and more attention, that the information in this article is presented.

Both of these weeds are of purely American origin, and can not be inveighed against as foreign intruders that should have been kept out of the country. One comes from the south and the other from the west, and neither from any great distance. If cultivated farms had not taken the place of the original prairies and oak openings in this fair State, the horse nettle and the buffalo bur would still be unknown within our borders.

Although of very different general appearance and habits of growth, these two weeds are closely related, both being solanums, the horse nettle, *Solanum Carolinense*, and the buffalo bur, *Solanum rostratum*. Some of their near relatives are well known plants of diverse qualities. On the one hand are such esteemed vegetables as the potato, *Solanum tuberosum*, and egg plant, *Solanum melongena*, on the other hand are poisonous weeds like the climbing nightshade, *Solanum dulcamara*, with its attractive scarlet berries, and the black nightshade, *Solanum nigrum*, found in gardens and fields. Other close relatives are prized for ornamental purposes, as the trailing or climbing greenhouse vine, *Solanum jasminoides*, and the old fashioned house plant, the Jerusalem cherry, *Solanum pseudocapsicum*. Such knowledge or relationship serves among other things, to explain certain resemblances in flower, fruit or leaf, that the two weeds exhibit, but it does not go far in providing suggestions to the cultivator for checking their advance or getting rid of their presence.

HORSE NETTLE.

This weed is occasionally called Sand Brier, in Delaware the name Sodom Apple is much used, and according to Professor Stanley Coulter it is known as Tread Softly among the negroes of southern Indiana. There are probably other local names, but almost everywhere in the State where it is common the name of Horse Nettle has become well fixed.

The plant has a general resemblance in its growth to the potato, but without such abundant foliage. It becomes one or two feet high, and is somewhat spreading, or even straggling when in rich soil. The leaves are from two to six inches in length and like those of the potato variable in outline. The pale blue or white flowers, an inch across, arranged in racemose clusters, have a close resemblance to those of the potato, and also the round yellow berries that follow are like potato balls, but not so large. The stem and leaves are somewhat sparingly beset with rather stout yellow prickles, often a quarter of an inch long, that are straight, smooth and sharp, and make the plant disagreeable to handle and duly respected by animals. It is probably from these prickles that the plant derives its name of Horse Nettle, although they have no stinging qualities like those of a true nettle. A characteristic of the plant that makes it especially pernicious as a weed is the habit of sending its roots deep into the soil and extending them laterally to considerable distances. The main roots are from an eighth to a quarter of an inch thick, are long lived, persisting from year to year, and whenever broken will send up sprouts to start new plants. Plowing and partial cultivation often act on this account to increase and spread the weed rather than to check it. **(See fig. 1.)**

The plant, therefore, is easily identified by its long, sparingly branched, perennial roots, its sparingly prickly stem and leaves, its potato-like flowers and its smooth yellow fruit.

The horse nettle was originally an inhabitant of the southern states, from North Carolina to Texas. It has gradually crept northward as cultivation of the soil and facilities for transportation have increased, until now it extends from the Gulf of Mexico northward to Connecticut, southern Ontario, northern Indiana, Illinois and Nebraska. The continuation of its travels northward depends not only upon tillage and ready carriage, but upon the capacity of the plant to adapt itself to the colder winters and more severe climate of northern regions. So far as Indiana is concerned it has invaded every part of the State, and is rapidly

making itself a permanent factor in the weed problem of every county.


The first printed report of its occurrence in Indiana was made by Professor C. R. Barnes in 1876. He reported it from Jefferson county on the Ohio river. But we learn from Professor Stanley Coulter, whose early home was in that county, that it was probably a very common and troublesome weed in the region even before that time. It is now very abundant in all the counties lying along the Ohio river, and rather common throughout the southern half of the State, while in the northern half it is found sparingly, but in increasing numbers. It put in an appearance on the college farm about 1895, having come through impure field seeds.

Fig. 1.—Roots of Horse Nettle taken in September; *x*, surface of the soil; *y*, point at which the roots were cut off by the plow at the previous spring plowing; *z*, point at which the roots were cut still a year earlier. Three deep lateral shoots are shown (one turned up in photographing).

Letters of inquiry, accompanied with specimens of the weed, have been received at the station from the following persons, in the order named:

HORSE NETTLE REPORTS.

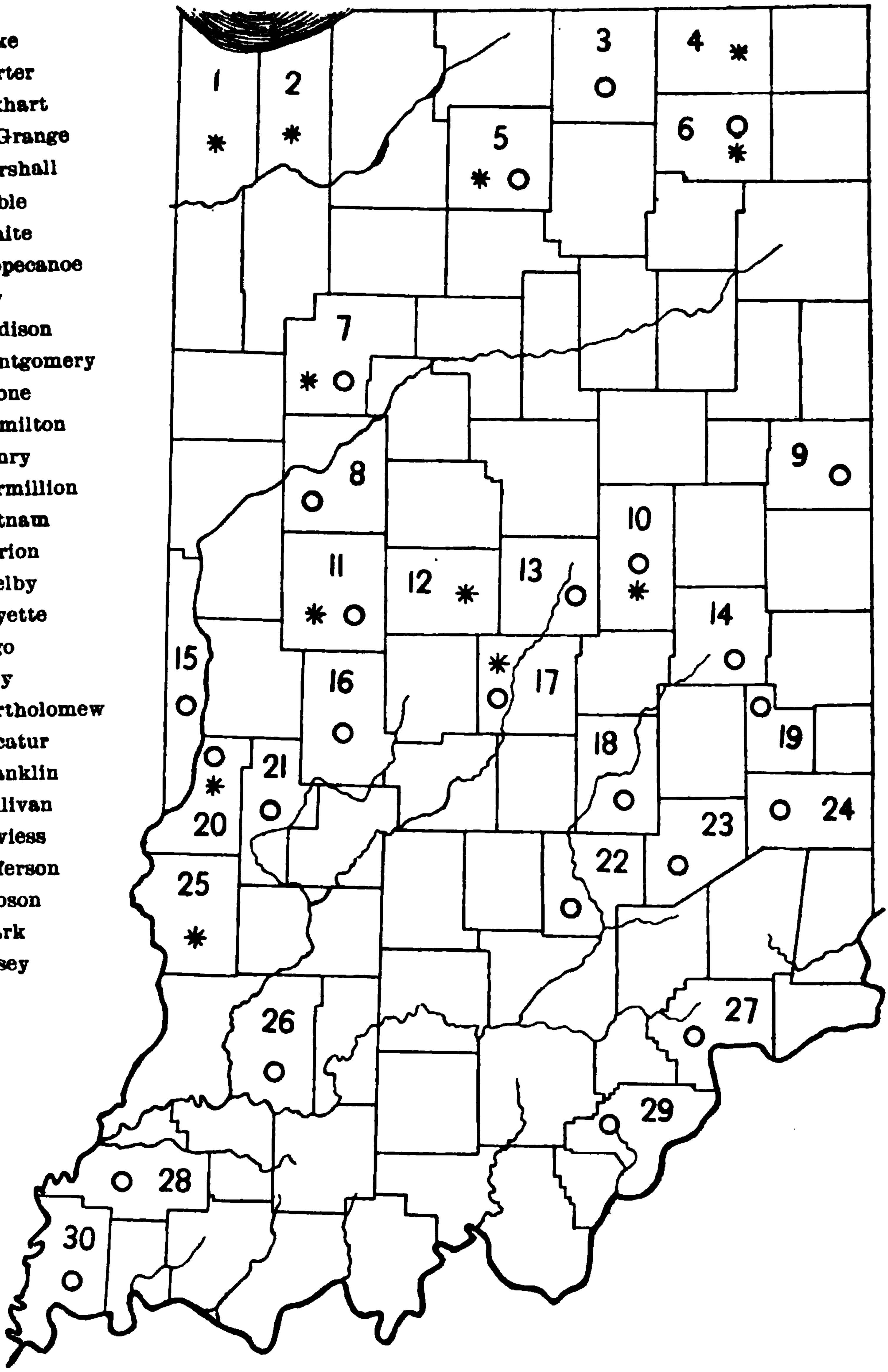
CORRESPONDENT	COUNTY	POST OFFICE	DATE OF LETT'R
Pleas, Elwood....	Vigo.......	Terre Haute..	Dec. 3, 1894
Nash, J. G........	Clark.......	Bethlehem.....	Dec. 10, 1894
Jackson, Joseph..	White	Wolcott	July 27, 1897
VanNatta, J. C...	White	Brookston.....	Aug. 29, 1898
Dawson, J. E.....	Clay........	Brazil	Aug. 29, 1898
Collins, E H.....	Hamilton,...	Carmel........	July 28, 1898
Hoover, D. F.....	Jay	Pennville......	Oct. 20, 1898
McIlvaine, A. R..	Henry.......	Lewisville.....	July 4, 1900
VanNatta, J. C...	White	Brookston.....	Oct. 4, 1900
Fluegel, W. G....	Elkhart	Nappanee.....	June 25, 1901
Wood, J. B.......	Madison....	Summitville....	Sept. 21, 1901
Voreis, L.........	Marshall ...	Hibbard	Oct. 1, 1901

To the above may be added the following county reports taken from the "Catalogue of Plants of Indiana," 1899, by Professor Stanley Coulter, of Purdue University: Tippecanoe (Alida M. Cunningham), Daviess (H. J. Clements), Jefferson (Charles R. Barnes), Gibson and Posey (J. Schneck), Clark (J. F. Baird and J. L. Taylor), Franklin (O. M. Meyncke), Vigo (W. S. Blatchley), Noble (W. B. VanGorder), Putnam (D. T. MacDougal), Vermillion (S. G. Wright), Decatur and Shelby (J. C. Ballard), Hamilton and Marion (G. W. Wilson), Fayette (Robert Hessler), Montgomery and Bartholomew.

The data here recorded are displayed on an accompanying map of the State. It will be seen that the reports have come from the whole length and breadth of the State, but are most numerous from the central part where the weed is now attracting most attention, and less so from the northern part where it is yet rare, and from the southern part where it is so common as to be known to most cultivators.

The horse nettle prefers deep, rich soil with a considerable admixture of sand, through which the long roots may readily penetrate, but will grow in all kinds of soil when once established. Imperfectly cultivated fields, especially after being turned over into meadows, are particularly in danger of being occupied. Plowing tends to cut up the roots and thus multiply the number of plants.

1 Lake
2 Porter
3 Elkhart
4 LaGrange
5 Marshall
6 Noble
7 White
8 Tippecanoe
9 Jay
10 Madison
11 Montgomery
12 Boone
13 Hamilton
14 Henry
15 Vermillion
16 Putnam
17 Marion
18 Shelby
19 Fayette
20 Vigo
21 Clay
22 Bartholomew
23 Decatur
24 Franklin
25 Sullivan
26 Daviess
27 Jefferson
28 Gibson
29 Clark
30 Posey



Map of Indiana, showing the distribution by counties of two weeds: Horse Nettle (*Solanum Carolinense*), indicated by a circle, and Buffalo Bur (*Solanum rostratum*), indicated by a star.

The natural means of distribution is undoubtedly by seeds for the most part. The soft yellow berries are attractive to animals, especially birds, providing a delicate morsel. The small indigestible seeds are thereby distributed to considerable distances. The seeds may also become an impurity in commercial seeds, especially of farm crops, but on account of the juicy character of the berry in which they are enclosed it is rather difficult for them to be freed from the pulp, or to escape the usual cleaning process if retained in the dried berry. The plants on the college farm are supposed to have been introduced with the seed of the sugar beet.

Where there is already a beginning, the multiplication of the plants within a limited area is very rapid, both by means of the numerous many seeded berries and by sprouts from the extensive root system. Plowing and subsoiling as a rule hasten the process.

In exterminating this weed, the first step is to limit as much as possible any further multiplication of individual plants or their extension outside the original area. This is to be done by removing the tops wherever they appear, and thus prevent seeding. But the roots in the soil will still continue to send up shoots with great persistency. To remove the last vestige of growth requires drastic and uninterrupted methods.

Two principal methods are open to the cultivator for ridding the land of this pernicious weed; hoed crops and smothering. If hoed crops are adopted, the land should be cultivated until planted; then corn, beets, or some such crop should be used. After the crop appears above ground, horse and hand hoes should be applied unsparingly until harvest, cutting the weeds away well below the surface of the ground. The longer shoots the plant is forced to produce in order to again spread leaves to the air and light, the greater will be the exhaustion of the root system and the less time it will have in which to recuperate before again being cut down. In this way the growth becomes feebler and feebler. But to be eventually effective, no opportunity during the whole season must be given through a period of negligence for any considerable growth, and consequent regaining of vigor. Plowing the field at the end of the season will expose some of the enfeebled roots to the action of frost and complete their destruction. A second season of similar vigilance will usually remove all trace of the weed.

If the method of smothering is adopted, the ground is given

up to some thick, rapidly growing crop, such as rape, barley, millet or oats, which will take possession before the weed is able to make much headway. The crop should be sown thickly, and on a good soil will so shade the ground that only a light growth can be made by the weed. If rape is chosen, the field may be pastured after the rape has made a good stand, or it may be cut and fed to stock. After the crop has been removed, whichever one has been chosen, the land may be plowed and harrowed occasionally until time for sowing clover or winter rye. The harrow will bring many roots to the surface to be killed by exposure. Afterward the clover or rye will choke down the horse nettle in late fall and early spring following; and then the whole may be turned under as a green fertilizer, and the land be used for a hoed crop during the second season. If this method has been faithfully followed up, the beginning of the third season should find the land wholly free of horse nettles.

In carrying out any method of eradication, watch should be kept for stray plants along hedgerows, fences or untilled borders. A plant or two overlooked may restock the field with weeds in less time than it has taken to banish them. In such places chief reliance must be had on the hoe to keep the plants from producing foliage to any extent, and thus gradually to enfeeble and kill them. The application of kerosene or strong sulphuric acid to the cut end of the stem, hoping that it would follow down the long root and kill it well into the ground, was carefully tried by Professor Beckwith of the Delaware Station, and found ineffective. In places like these, where the usual cultivation can not be applied, repeated cutting away of the plants and digging out of the roots are the only satisfactory means of extermination known.

Finally, it should be borne in mind that no method of weed extermination will succeed unless the cultivator is impressed with the seriousness of the situation, and is willing to give due and persistent attention to the matter. The words of Dr. William Darlington in regard to the horse nettle, which are to be found in his excellent treatise about weeds and useful plants, written in 1847, might well be remembered by every farmer of Indiana. "This is an exceedingly pernicious weed," he says, "and so tenacious of life that it is almost impossible to get rid of it, when once fully introduced. It grows in patches so thickly as to deter stock from feeding among it, and even to monopolize the soil; while its roots gradually extend around, and to a great

depth. The farmers will do well, therefore, to enable themselves to know it when they meet it, and moreover, to eradicate it, promptly and effectually, wherever they find it on their premises."

BUFFALO BUR.

This solanaceous weed is of very different habit from the horse nettle, but is equally pernicious. It passes under a number of names beside the one here adopted, but none so distinctive or so generally used. It is not infrequently spoken of as Sand Bur, and occasionally as Beaked Nightshade or Spiny Nightshade.

The plant is an annual, starting early in the spring from seeds scattered upon the ground the previous year. It grows one to two feet high, with numerous branches and rounded top. The watermelon-like leaves are rather soft on account of a fine pubescence, but also have long sharp prickles. The leaves are two to five inches long. The flowers, borne in small lateral racemes, are of the form and size of those of the potato, but are bright yellow and rather showy. The stems and pods are thickly beset with straight, sharp prickles, becoming, especially on the pods, a half inch or more long, which make a rather formidable armature. The fruit is a round berry, botanically speaking, closely covered with the spiny calyx. (See fig.) But ecologically and for all practical considerations, it is a pod, filled with a juicy pulp that becomes mucilaginous, and finally as the fruit ripens dries up and leaves the numerous black seeds free in the upright spiny pod, which has now become cup-shaped with five slits half way down the sides, making five points around the rim. The roots are fibrous and not very long, and die when the plant ripens in the fall.

This weed, therefore, is readily recognized by its annual roots its very prickly stem and pods, the melon-like leaves, its yellow, potato-like flowers, and the numerous round, bur-like pods.

In rich, light soil the plants sometimes attain great size. A plant is reported from Iowa (StationBulletin No. 28) that was nearly six feet across, although only eighteen inches high, and bore 1,985 pods, which would have produced, had they been permitted to ripen, over a hundred thousand seeds.

The original home of the Buffalo Bur was in southwestern United States on the great plains. In Gray's Synoptical Flora

(published 1878 to 1886) the range is given as plains of Nebraska to Texas and Mexico. This region was also the home of the buffalo, and the common name is said to have arisen on account of the readiness with which the burs became attached to the long fur of that animal. The plant has now wandered far from its native prairies, and the experiment stations, so remote from the region where its journey began as Montana and Maine, are called upon to write its history and warn their constituents against its aggressions. The facilities for commercial transportation have been the special impetus in its distribution, and it appears to adapt itself with ease to the climatic conditions of northern regions. Like many plants from countries subject to hot dry summers, it can blossom and ripen seeds on exceedingly depauperate individuals, if there is sufficient heat in midsummer, although the length of the season and other conditions for growth may be unfavorable.

It was first reported for Indiana from the adjoining counties of Vigo and Sullivan by Mr. W. S. Blatchley, now State Geologist of Indiana. These counties are on the western border of the State, not much below the middle. The next report was from Lake county at the extreme northwestern corner of the State.

Up to the present time it is known to have appeared in twelve counties of the State, none of which are further south than Sullivan. It seems to have traveled from the west or northwest, as it first came into the State from that direction and is yet unreported from the south and southeastern third of the State. (See map.) Letters of inquiry, accompanied with specimens of the weed, have been received at the station from the following persons, in the order named:

TABLE I.

Buffalo Bur Reports.

CORRESPONDENT	COUNTY	POST OFFICE	DATE OF LETTER
Wright, S. G.....	Boone	Thorntown...	Aug. 11, 1893
Carter, Thos.....	LaGrange ..	LaGrange....	Aug. 28, 1894
Walker, F. A....	Madison....	Anderson	Dec. 7, 1894
Rogers, Sig......	Montgomery	Crawfordsv'le	Dec. 10, 1894
VanBushirk, J. B	White......	Buffalo.......	Sept. 4, 1895
Kimmel, G. A....	Noble,......	Albion........	Sept. 23, 1895
Fifield, B.......	Porter......	McCool.......	Sept. 15, 1898
Ettinger, G. D...	Marshall ...	Bourbon	Sept. 17, 1898
Prough, Bittler..	LaGrange ..	Scott.........	Sept. 28, 1900

To the above may be added the following localities reported by counties, taken from Coulter's "Catalogue of Plants of Indiana:" Vigo and Sullivan (W. S. Blatchley), Lake and Porter (E. J. Hill), Marion (Robert Hessler), and Montgomery. Nowhere in the State does the weed occur in any abundance. Most of the correspondents speak of single plants only. But it is an aggressive weed, sure to spread, and to become common and heartily detested, at least in some parts. The evil day should be put off as long as possible by meeting its early appearance with prompt extermination wherever and whenever possible.

The following extract from letters of correspondents are inserted here to show the general character of the reports received at the Station, and also to give detailed information from first hand. They will doubtless help other residents of the State to recognize the weed upon its first appearance.

Anderson, (Madison Co.) Dec. 7, 1894.

I found three plants this summer along the line of the Pan Handle railroad. The plants were growing near the water station in this city, and I judge the seed was brought in from the north. FRANCIS A. WALKER.

Crawfordsville, (Montgomery Co.) Dec. 10, 1894.

I send under separate cover a box containing a seed stem of a plant that is new to me. I found it last summer while hoeing in a three acre piece of young blackberries. It was just beginning to bloom, and was so odd looking I let it stand to see what it would do.

The leaves strongly resemble watermelon leaves. The plant grew fourteen to sixteen inches high, and had a spread of fully three feet. the branches standing out nearly horizontal, very stiff and unyielding. The branches were held up firmly off the ground. The entire plant was thickly covered with spines or thorns.

The flowers were a beautiful yellow, and very "catchy" to the eye. The plant has rather an attractive appearance, and would grace a lawn if it did not prove itself a nuisance.

SIG. ROGERS.

Albion, (Noble Co.) Sept. 23, 1895.

It grows about fifteen inches high and the blossom is the same shape and color as a tomato blossom. There was but the one plant to be found. G. A. KIMMEL.

Scott, (LaGrange Co.) July 28, 1900.

I send you a branch of a weed that has sprung up in my garden. Where the seed came from I do not know. It grows like a

tomato, has yellow blossoms, and thorns all the way from the ground. It is two feet high and has fourteen branches. I send you a part of one branch. It is still growing, and I do not know how much larger it will get. BITTLER PROUGH.

As the plant is an annual its distribution is by seeds. Although the fruit starts out as a berry, it changes after ripening into what for practical purposes may be called a pod. The pod is held stiffly upright, even after the plant is dead and dry, and, standing somewhat open at the top, the seeds are flung out as the wind, especially when it comes in violent gusts, sways the pods back and forth. It has been said that the pods will cling like burs to the hairy coats of animals, and the seeds be thus distributed, but this, it seems to me, must be an error, for there does not appear to be the proper adaptation. The pods, although bur-like, have smooth straight prickles, and not rough or barbed ones, as usual in such cases. Moreover, the pods do not readily separate from the plant. On the contrary, they are held firmly in place by the stems, the whole framework of the plant remaining through the winter in the position assumed while growing. The sharp prickles on the pods, so much longer than elsewhere on the plant, doubtless serve to protect the soft berries within from being eaten. Possibly the seeds will not withstand the action of gastric juice and keep their germinating power. But of this nothing is known. At any rate the pepper-box method of sowing the seeds, seems to be the natural one for the plant.

It appears that in most places where found eastward from its original home, it has been carried with western grain or has come from the refuse emptied from cattle cars. Its long distance distribution is undoubtedly as an impurity in farm and garden-seeds, for the most part.

The Buffalo Bur thrives best in rich sandy soil, but grows readily along edges of fields, roadsides, and any place where Cocklebur will succeed. It has all the insinuating habits of a thrifty weed, and should be granted no quarter.

Being an annual, its extermination only requires that it be kept from seeding. This can be done by cutting or pulling, during the early part of the season, and by gathering the plants and burning them, if the pods are formed. If mown off, or if the hoe does not strike well below the surface of the ground, the stump will send out short branches that will produce seed. It is a clever device by which the weed gets the better of the careless farmer. Some vigilance and a little persistency will enable the cultivators of Indiana to keep the Buffalo Bur wholly in check, and possibly to banish it from the state. The result will be well worth the effort, for it is one of the most noxious of weeds.

AN EDIBLE FUNGUS.

By J. C. Arthur.

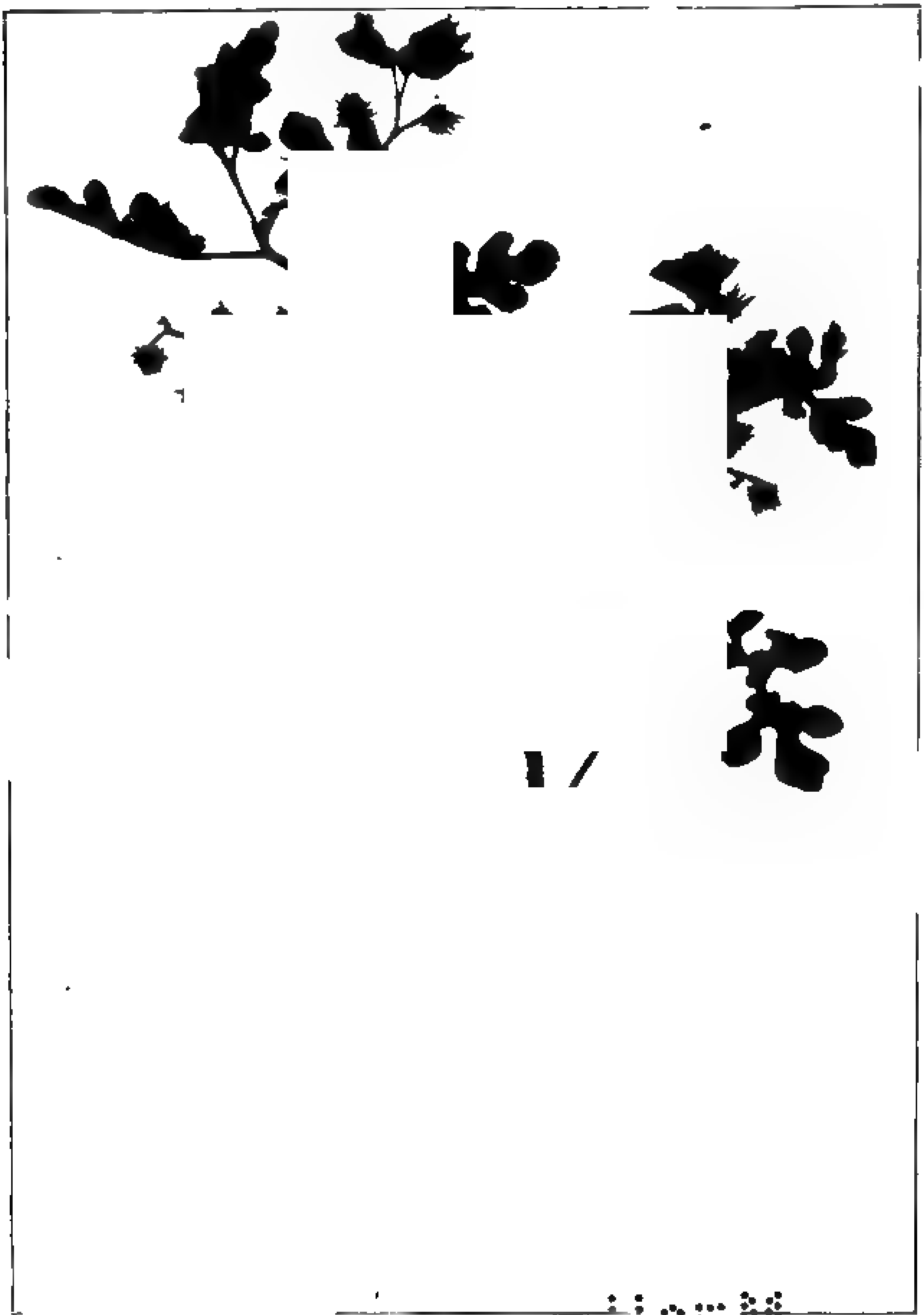
In the State of Indiana there are hundreds of species of fleshy fungi, and of these probably not over two per cent. are poisonous. A considerable proportion, however, must be classed as undesirable for food by reason of their toughness, ill flavor or indigestibility. The remainder of truly edible species is after all a large one. They are to be found in woodlands and pastures, often in large numbers, from early May to December. Their value as nutritious and palatable food is unquestioned. From the times of the Caesars to the present they have been held in high esteem by epicures. It does not, however, require a cultured taste to appreciate them. Were it not for the dire consequences that follow the eating of innocent looking, but poisonous kinds, they would soon be a favorite dish with people of every station in life, and especially with those who live in the country and can have them served upon their tables when freshly gathered and with the omission of the deterring preliminary of paying from fifty cents to a dollar a pound for them.

The question of questions with the would-be fungophogist is: "How can one tell the poisonous from the edible kinds?" The more usual form of the question is: "What is the difference between mushrooms and toadstools?" The two questions, however, are quite distinct. The most sensible answer to the latter is: "None!" The most sensible answer to the former is: "Learn to know them as you learn to know other objects in nature." The woodsman does not have a rule by which an ignorant person could go into the woods and tell by inspecting a tree whether it would make good, high-priced lumber or not. He must know an oak from an elm, a walnut from a poplar, and he must even know the different kinds of oaks and walnuts. If one wishes to eat mushrooms and toadstools, let him learn to recognize some desirable kinds, by asking those who know, or by close comparison with adequate descriptions and illustrations. This may be a slow process, but if good judgment and care are exercised, it is a certain and efficient one.

There are some kinds of edible mushrooms that are so peculiar in outline and appearance that when once pointed out they are afterwards easily recognized. Such a one, it seems to me,

HORSE NETTLE.

Branch of Horse Nettle, showing flowers, and in the lower left hand corner a cluster of immature berries. Photograph made from a dried specimen, and reduced in size.



BUFFALO BUR.

Branch of Buffalo Bur, showing young fruit. Photograph made from a dried specimen, and reduced in size.

BUFFALO BUR.

Part of a fruiting branch of Buffalo Bur, showing the racemose manner of branching, the prickly stem and the upright spiny pods. Natural size.

AN EDIBLE FUNGUS.

Spiny or Hedgehog Mushroom (*Hydnum erinaceum*), found on a stump in open woodland. When growing the spines hung directly downward, the lower right hand corner of the figure being the uppermost part when in a natural position. The spines are small and delicate, almost hair-like, on the top, or part exposed to rain, but long and straight beneath. About half natural size.

SPINY OR HEDGEHOG MUSHROOM.

Specimen shown on the preceding plate cut in two and laid open right and left, showing the solid interior, and the long spines on what was the under side. The straight side of the fungus, in the middle of the plate, grew against the stump.

is the Spiny or Hedgehog Mushroom (*Hydnum erinaceum*). It grows on dead stumps or logs in open woods, is of a pure white color, turning yellowish upon aging or drying, and possesses a quite uniformly solid texture. It has a thatching of pendant spines, an inch or so long, of the same firm white substance as the body of the fungus. Single specimens range from two or three to eight inches across, and often weigh several pounds. They are usually of a rounded compact form, but may be quite irregular in outline. They occur in the fall, and can be found in good condition until freezing weather begins.

The whole fungus is sliced and cooked without paring or preliminary soaking in weak vinegar or brine, as recommended for some kinds. It may be simply fried in butter, but as it is rather dry, it is better cooked in some way by which its naturally scanty juices may be supplemented.

This fungus is not much subject to insects, fortunately, and it keeps well, if gathered when young, so that it can be used at convenience during a number of days after gathering, possibly a week or more, if kept in a cool place.

There are fourteen species of hydnums listed for Indiana, all characterized by soft spines, and none accounted poisonous. But only a part of these kinds are desirable for eating. The hedgehog hydnum, here described is one of the best edible kinds, and another quite as good and equally common in the State is the coral hydnum. Of this latter a description may follow at some future time.

EFFECTS OF RENEWING THE HUMUS IN CONTINUOUS CORN CULTURE.

By W. C. Latta.

In 1894 an experiment was begun for the purpose of determining the effect of renewing the supply of humus on the yield of corn.

The piece of ground used for this experiment contains a series of 1-16 acre plats and has been in corn continuously since 1880. The last application of manure on this ground was in 1884. Therefore for ten years prior to the beginning of the experiment, the humus had been steadily reduced by the complete removal of the corn crops and by the frequent cultivation incident to growing this crop. The entire crop of grain and stalks had been removed every year and the ground had been regularly left bare on the removal of the corn crops up to 1894. Beginning with 1894 the corn stover produced on two plats of the series the year previous, was passed through a feed cutter and returned to the plats at the time of plowing. On two other plats, wheat straw, equal in weight to the corn stover produced was turned under. On a third pair of plats crimson clover was sown in the fall of 1893 to be turned under the succeeding spring. The alternating plats received nothing. The treatment begun in 1894 has been continued without interruption to the present.

The results of the experiment as to yield of grain for the years 1894 to 1900 inclusive, are summarized in the following tables. In table II the average yields of the pairs of plats which received corn stover, straw and crimson clover respectively, are compared with their flanking plats, which received nothing. Three sets of comparisons are made, namely:—

(1). For the three years just prior to the beginning of the experiment, (2) for the first three years of the test, and (3) for the last three years. The points of interest in the table are the differences in yield of the treated and untreated plats.

For the years 1894-1900, the corn stover was returned to plats 1 and 3; wheat straw was applied to plats 7 and 9; and crimson clover as sown on plats 13 and 15. The flanking plats Nos. 2, 4, 6, 8, 10, 12, 14 and 16 received nothing.

TABLE II.

Showing the Effects of Renewing the Humus, on Yields of Corn.

Years	Plats	Treatment	Yield per acre		Increase per acre.	
			Bu. Corn	Lbs. Stover	Bu. Corn	Lbs. Stover
1891–3	Nos. 1 and 3	Nothing	19.18	1403.00		97.00
	" 2 and 4	"	19.99	1306.00	*— .81	
1891–3	Nos. 7 and 9	Nothing	23.14	1569.00	.60	23.00
	" 6, 8 and 10	"	22.54	1546.00		
1891–3	Nos. 13 and 15	Nothing	21.96	1590.00		12.00
	" 12, 14 and 16	"	23.68	1578.00	—1.72	
1894–6	Nos. 1 and 3	Stover	15.85	1586.00	.81	
	" 2 and 4	Nothing	15.04	1588.00		—2.00
1894–6	Nos. 7 and 9	Straw	24.67	1902.00	2.13	
	" 6, 8 and 10	Nothing	22.54	1923.00		—21.00
1894–6	Nos. 13 and 15	Crimson Clover	20.45	1739.00		
	" 12, 14 and 16	Nothing	21.83	1811.00	—1.38	—72.00
1898–1900	Nos. 1 and 3	Stover	32.96	1896.00	6.56	170.00
	" 2 and 4	Nothing	26.40	1727.00		
1898–1900	Nos. 7 and 9	Straw	35.41	2172.00	5.02	177.00
	" 6, 8 and 10	Nothing	30.39	1995.00		
1898–1900	Nos. 13 and 15	Crimson Clover	30.18	1782.00	1.88	
	" 12, 14 and 16	Nothing	28.30	1874.00		—92.00

*The minus sign (—) means loss.

In the three years (1891-3) previous to beginning the experiment, plats 1 and 3, and also plats 13 and 15 to which stover and crimson clover were, later, respectively applied yielded a little less grain, but more stover than their respective flanking plats; while plats 7 and 9 showed a little greater yield of both grain and stover than the flanking plats. The results of the first three years show that the several plats were about equally productive.

In the next three years (1894-6) all three pairs of treated plats show reduced yields of stover, while the plats which received stover and straw gave somewhat larger yields of grain. This means that the applications of stover and straw were beginning to exercise an influence on the yield of grain. The clover plats for the same period show a slight falling off in yield of both grain and stover. No appreciable gain from the clover could have been expected at this juncture for the reason that the clover made very little growth in the fall and was quite generally killed out by the winter. Just why a negative result, that is a decreased yield should appear, is not at all clear.

Turning now to the last three years of the experiment, we find that with a single exception (the stover on the clover plats), all three pairs of treated plats show gains. The comparatively small return from the crimson clover is again due to its poor growth in fall and to winter killing.

All the plats both treated and untreated, show gains in the last period as compared with either of the other periods.

By comparing the gains in percent of increase, the better results on the treated plats are more clearly brought out.

Taking the yields during the three years previous, of the several sets of treated and untreated plats as the base, the gain in per cent of increase was found by a simple calculation. The results so far as the yield of grain is concerned, are given in table III for the first three, and also for the last three years of the experiment. The fourth column of the table also shows the balance of gain in per cent during the last three years, in favor of the treated plats in each set as compared with their respective flanking plats.

TABLE III.

Shewing Percent of Increase in Yield of Grain, the First Three and the Last Three Years of the Experiment, as Compared with the Three Preceding Years.

PLATS	Increase or decrease first 3 years	Increase last 3 years	Balance in favor of treated plats
	per cent.	per cent.	per cent.
Stover 1 and 3	17.36	71.85	39.78
Flanking 2 and 4	24.76	32.07	.....
Straw 7 and 9	6.61	53.02	18.19
Flanking 6, 8, 10	0.00	34.83	.....
Clover 13, 15	—6.88	37.43	17.92
Flanking 12, 14, 16	—7.81	19.51	.....

The figures in the fourth column show that the net gain in percent of yield was about as great on the clover plats as on the straw plats, while the net gain on the stover plats was more than twice as great.

Reverting again to table II, the results for the last period, on the stover and straw plats are in line with what might be expected. The increase in yield of grain on the clover plats, for this period, is also to be expected.

Why the apparently negative result as to yield of stover on these plats? In answer to this query we should note (1) that the result is not really negative, as there is an actual increase in yield of stover as compared with the two preceding periods, and (2) that this increase, was overshadowed by the larger increase of stover on the flanking plats. It should be noted further that all the negative results as to stover are slight and not greater than may be accounted for by differences in the dryness of the corn shocks at the time of weighing.

In any case the results of the experiment, as a whole, clearly indicate the wisdom of returning the stalks or straw of the farm crops—or some fair equivalent, to the land as a means of renewing the humus and restoring a portion of the plant food removed by these crops.

INDOOR TOMATO CULTURE WITH CHEMICAL FERTILIZER.

By William Stuart.

During the past three seasons of 1898-'99, 1899-'00, and 1900-'01, a series of experiments have been conducted in the greenhouses of the botanical department of this station. The work undertaken by the writer, under the suspervision of Dr. Arthur the station Botanist, had for its object the determination of the particular element or elements of plant food necessary to the growth of the tomato plant in order to secure a maximum crop of fruit. Other questions of minor importance were also given some attention. While the experiments performed are mostly of a preliminary nature, the results are of sufficient interest to warrant publication.

It has been the aim of the writer to study the needs of the plant in the way of plant food and to furnish as uniform conditions of heat and moisture as was possible.

Two methods of growing the plants were adopted, one of which was in benches, the other in pots. In both methods water was supplied to the plants from underneath the soil.

The bench used for this work though small proved fairly satisfactory. It was divided into four sections of equal size, 3 ft. 9 in. by 4 ft. 8 in. in area. These sections for the sake of convenience have been numbered from I to IV and will be so designated wherever alluded to in the text.

Soil.—The soil in all experiments was a black loam of medium fertility. It was prepared for use by passing it through an eighth inch wire mesh screen, and then thoroughly mixed by shovelling over several times before using. By this method of preparation the texture and composition of the soil was as nearly uniform as it was possible to obtain.

Application of Fertilizers.—In the application of the chemical fertilizers considerable care was exercised in order to insure their uniform distribution throughout the soil. In general, with the exception of the phosphoric acid, only a portion of the fertilizers was added to the soil previous to setting the plants. The balance of these ingredients was either applied to the surface and lightly stirred into the soil or it was applied in solution by the sub-watering method.

CULTURAL DETAILS.

The cultural methods adopted were similar to those usually employed in commercial work. The seed was sown in flats or pans in friable soil, and when the seedlings were of sufficient size, usually when the first true leaf was formed, they were potted off into 2½ inch pots. From these they were shifted to 4 inch pots, and on one occasion when the space in which they were to be placed was not at once available, they were transferred to 6 inch pots. From these pots they were transplanted into the bench or pot in which they were to be grown.

Varieties Grown.—In the first season's work two varieties of tomatoes were grown. These were the Lorillard and Stone. The latter variety proved to be the more desirable one in cloudy weather owing to its maturing more pollen than that of the Lorillard which failed to set its fruit even by artificial fertilization, during a succession of dull cloudy days. For this reason it was abandoned the following season. In the third season's work the Stone and Sutton's Best of All were grown.

Training the Plants—With the exception of the first season on the bench, all the plants were trained to a single stem. In the exception mentioned, each of the three plants in the section were grown differently. One in each section being trained to a single stem, one to a main stem and one lateral, while the third was grown with a main stem and two laterals. This method however was found to be unsatisfactory where uniformity of growth was desired, greater variations occurring in the laterals than when trained to a single stem.

Watering.—As has been previously stated, all plants with the exception of the last pot experiment were watered from below. This was accomplished in the case of the bench grown plants by having the bottom of the bench covered with a watertight zinc pan about four inches in depth, the pan being filled with a solid layer of soft brick. These were set on edge, and to facilitate the distribution of the water the lower edges of the bricks were removed, this of course being done prior to laying them in the pan. The floor of bricks was then covered with soil to the depth of seven inches. The water was conveyed to the pan by means of a zinc tube inside of the bench, extending from the top to the bottom of it. For fuller details concerning this method of watering plants, the reader is referred to bulletin 66 of this Station, pp. 54-55.

according to analysis by the chemical department, 13.34 per cent. of available phosphoric acid, the muriate of potash about 50 per cent. of potash and the nitrate of soda about 16 per cent. of nitrogen.

As has been previously explained the plants were grown to a single stem and with one and two laterals. Those grown to a single stem proved the most satisfactory because their growth was so much more uniform. On account of an unusual amount of dull cloudy weather during November and December, the first blossom clusters failed to mature sufficient pollen to fertilize the pistils, hence no ripe fruits were gathered till February 24, the last ripe fruits were gathered on June 9, making a fruiting period of about fifteen weeks.

Weight of Fruit.—A record was kept of the number and weight of fruits from each plant, as well as from each section. The data which is presented in table V shows an appreciable gain where the fertilizers were used. In the average number of fruits per plant there was but a slight difference in all except section IV, which showed an increase of one third over that of the control. In the total weight of fruits per plant there was a marked increase over that of the control, the nitrate of soda

TABLE V. FIRST SEASON'S CROP.

Average number and weight of ripe fruit per plant from each section. Feb. 24th to June 9th, 1899.

Number of section.	Average number of fruit per plant.	Average weight of single fruits.	Weight of fruits per plant.	Per cent. of increase over control.	Fertilizer used.
I	30.3	86.5 grams	2620.3 grams	......	none.
II	31.7	106.5 "	3375.7 "	28.8	nitrate soda.
III	31.	114.4 "	3545. "	35.3	nitrate soda, acid phosphate.
IV	40.3	121.6 "	4900. "	87.	nitrate soda, acid phosphate and muriate of potash.

giving an increase of nearly 29 per cent. The addition of acid phosphate to the nitrate of soda gave a still larger increase, a gain of over 35 per cent. being obtained, while with the application of all three ingredients an increase of 87 per cent. was secured.

The average weights of the fruits were in accordance with

the preceding data, that is, the fruit from the control plants were the smallest, the size increasing in sections II, III and IV, in the order named.

Second Season. —In order to avoid the difficulty experienced in setting fruit during the short, cloudy days of early winter, the seed for this crop was sown over a month earlier, or on August 10. The seedlings were potted off August 24, and shifted to four inch pots September 4, from whence they were transferred to the bench September 18. Four plants were grown in each section, and these were grown to single stems, the distance between the plants being fourteen inches. The divisions in the bench were made water-tight compartments, in order to permit of the sub-application of liquid fertilizers. It also permitted of more uniform conditions of moisture in the different sections, as each could be watered as desired.

The fertilizers used were the same as those in the preceding experiment, but their method of application was somewhat different. Instead of applying the balance of the nitrate of soda and muriate of potash to the surface of the soil, and stirring it in as in the previous crop, they were applied in liquid form by the sub-watering method.

Owing to more favorable weather and closer attention to pollination, the first ripe fruits were gathered November 18, and the last on April 23, a fruiting period of 22 weeks as compared with fifteen weeks in the preceding season. On account of this long fruiting period, an extra application of nitrate of soda was madeto the plants, hence the first crop grown only received four-fifths the amount of the second. This and the method of application is the only departure between the two crops.

In the accompanying table, VI, is presented the average number of fruits per plant from each section, together with their total and average weights. The increase of product over the control was again quite marked. In the nitrate of soda group, section II, the increase was about 13 per cent. The nitrate of soda and acid phosphate group, section III, gave an increase of over 66 per cent., while from that of section IV, to which all three ingredients had been added, the increase was only 57.9 per cent. Comparing these results with those of the preceding season, we find that plants in sections II and IV gave a much more marked increase the first season, while those in section III gave a greater increase the second season.

TABLE VI.—SECOND SEASON'S CROP.

Average number and weight of ripe fruit per plant from each section. Nov .18, 1899 to Apr. 23, 1900.

Number of section.	Average number of fruits per plant.	Average weight of single fruits.	Total weight of fruits per plant.	Per cent. of increase over control.	Fertilizers used.
I	18.8	113.3 grams	2130. grams	......	None.
II	22.3	108.1 grams	2411. grams	13.1	Nitrate of soda.
III	29.5	120. grams	3541.3 grams	66.3	Nitrate soda and acid phosphate.
IV	28.5	118. grams	3363.5 grams	57.9	Nitrate soda, acid phosphate and muriate of potash.

COMPARISON OF YIELD PER SECTION.

In tables V and VI representing the results obtained from the two season's crops respectively, the total weight of ripe fruits per plant from each section has been given. A comparison of these will seem to show that the yield was greater from the first crop than from the second. If however we take into consideration the fact that but three plants were grown in each section the first season and four the second, we will find that the total product from the plants in each section is greater from the latter. In table VII is given the total yield of ripe fruits in pounds from each section for both seasons. In sections II and IV the first season's product slightly exceeds that of the second, while I and III gives the largest yield from the second crop. In the

TABLE VII.

Total weight in lbs of ripe fruit from each section.

Season.	Number of section. I	II	III	IV	Total yield.
First	17.4	22.2	23.4	32.4	95.4 lbs.
Second	18.8	21.2	31.2	29.6	100.8 lbs.

case of III, the increase is over 33 per cent. The total yield from the four sections amounted to 95.4 and 100.8 lbs. respectively, an increase in favor of the second season of nearly six per cent.

VARYING AMOUNTS OF NITRATE OF SODA AND ACID PHOSPHATE.

Third Season.—The work of the third season consisted in a test of the effect of varying amounts of nitrate of soda and acid phosphate upon the yield of fruit. Seed of the Stone and Sut-

TABLE VIII.

Chemical fertilizers used in bench season 1900-'01.

	No. grams per section.				Approximate number ounces per sq. yd.			
	I	II	III	IV	I	II	III	IV
Acid phosphate...	372.1	372.1	372.1	496.	6.8	6.8	6.8	9.
Nitrate soda......	......	365.2	730.4	730.4	....	6.6	13.2	13.2
Muriate potash....	330.8	330.8	330.8	330.8	6.	6.	6.	6.

ton's Best of All Tomato were sown August 23, the seedlings potted off September 3 and shifted to four inch pots September 19. The plants were set in the bed October 9, two of each variety being set in each section, alternate plants, of each being grown. The chemical fertilizers added to each section are given in table VIII. As in the preceding experiments the acid phosphate was applied to the soil previous to setting the plants, and only one fourth of the muriate of potash and one sixth of the nitrate of soda. The balance of these were applied in three and five installments respectively.

The first ripe fruits were removed December 5 and the last on March 10, the fruiting period extending over 13 weeks. The average number of fruits picked from the plants in each section

TABLE IX.

Average number and weight of ripe fruit per plant from each section. Dec. 5, 1900 to March 10, 1901.

Number of section.	Average number of fruits per plant.	Average weight of single fruits.	Weight of fruits per plant in grams.	Per cent of increase over section I.	Fertilizers used.
I	22.75	107.9	2453.8	......	Acid phosphate, muriate potash
II	24.75	117.5	2907.5	+18.4	Acid phosphate, muriate potash, nitrate soda
III	19.	105.9	2017.8	—18.	Acid phosphate, muriate potash, nitrate soda
IV	27.25	81.9	2234.	— 9.	Acid phosphate, muriate potash, nitrate soda

together with their total and average weight are given in table IX. The results obtained show that the addition of a medium amount of nitrate of soda gave an appreciable increase in weight of product. When, however, the amount of nitrate of soda was doubled as in section III, it resulted in a proportionate decrease, the increase in the first case being a little over 18 per cent., while in the other the decrease was 18 per cent., or a difference between the two of over 44 per cent.

In section IV the increased amounts of both nitrate of soda and acid phosphate produced much better results than in the preceding one in which the nitrate of soda predominated. Apparently the additional amount of acid phosphate had a neutralizing effect upon the nitrate of soda.

SUMMARY OF BENCH EXPERIMENTS.

In order to place the essential features of the results obtained from the several chemical combinations employed during the three seasons, a table (X) has been constructed in which the yield of ripe fruits per section are given in pounds and ounces.

The grouping which follows embraces the product from plants with like chemical substances regardless of the method of application; and in the case of the third season of the amount applied. It will be noticed that considerable uniformity obtained,

TABLE X.

Yields of fruits per section from different chemical combinations.

Fertilizer applied.	Season of			Average product.
	1898-'99.	1899-'00.	1900-'01.	
	lbs. oz.	lbs. oz.		lbs. oz.
None	17.5	18.12	....	18.½
Nitrate of soda	22.5	21.4	....	21.12½
Nitrate of soda and acid phosphate	23.7	31.4	....	27.5½
Nitrate of soda, acid phosphate, and muriate of potash	32.6	29.11	*25.10	29.3¼
Acid phosphate and muriate of potash			21.10	21.10

*Only the product from section II table IX was taken. The yields from sections III and IV owing to their unfavorable character are not considered.

between the product from the control plants for the two seasons and also from those of the nitrate of soda sections. In the first

instance a variation of less than ten per cent occurs and in the latter of about five per cent.

In the nitrate of soda and acid phosphate group as well as that of the succeeding one in which all three ingredients were applied quite an extreme variation occurs, amounting to over 32 per cent. in the former instance and in the latter of over 24 per cent. While no definite cause can be attributed to the wide variation of the former other than the individual variation of plants, it nevertheless illustrates quite forcibly the necessity of repeated experiments in order to eliminate these occasional unexplainable variations. Of the latter variation it may be said that the crop of 1900 and 1901 was very much inferior to the two preceding ones in every respect, hence it would be manifestly unfair to make any close comparison with them. A comparison of the first two crops shows the variation to be reasonably within the limits of experimental deviations.

The average product from the first two crops gives an increase over the control plants for the nitrate of soda group of over 20 per cent., of the nitrate of soda and acid phosphate group of over 50 per cent., and of the complete fertilizer, of nearly 78 per cent.

POT GROWN PLANTS.

Although the greenhouse space available for the pot grown plants, was rather limited, consisting of two shelves about eleven feet long and a foot wide with a twelve inch space between them, yet by the use of water-tight zinc pots provided with the sub-watering device previously described, it was possible to divide the plants grown into a number of groups receiving different kinds and amounts of fertilizers and still have a sufficient number in each for comparison.

Of the three crops grown, no two are exact duplicates of one another, a slight increase being made each season in the amounts of chemical fertilizers applied to each pot.

First Season 1898-'99.—In this experiment sixteen plants were grown in the zinc pots. These pots were about ten inches in diameter and depth, and held about 25 pounds of the screened soil. Seed of the Stone tomato was sown September 14, the seedlings potted off October 2, shifted to four inch pots October 21 and to six inch pots November 14. They were transferred to the zinc pots Dec. 13. The delay in transferring them to zinc pots was occasioned by the space in which they were to be

grown, being occupied by chrysanthemums. One plant was grown in each pot, and trained to a single stem. They were allowed to grow until they reached the glass, or a height of about six feet.

The sixteen plants grown were divided into six groups, the first four of which included three plants each and the remaining groups two each. The chemical fertilizers used and their grouping, are given in table XI. Commercial forms of nitrate of soda

TABLE XI.

Fertilizers used in pot experiment, 1898-'99.

Number of group.	Raw bonemeal.	Acid phosphate.	Nitrate of soda.	Muriate of potash.	Approximate amount in ounces.
	grams.	grams.	grams.	grams.	
I	none	none	none	none	....
II	41.095	none	none	none	Bonemeal 1.4
III	none	17.415	10.709	none	Acid phosphate .6
IV	none	none	10.709	none	Nitrate soda .37
V	none	none	10.709	6.	Muriate potash .2
VI	41.095	none	10.709	6.	....

and muriate of potash were used. As in the case of the bench grown plants, only one-fourth of the nitrate of soda and one-half of the muriate of potash was applied to the soil previous to setting the plants. The balance of the nitrate was applied in solution from below in three applications, and that of the potash in one application. The acid phosphate used was supposed to contain an equal amount of available phosphoric acid, to that of the raw bonemeal.

The first ripe fruits were picked February 21 and the last on May 9, a bearing period of about eleven weeks. In the accompanying table XII, is presented the average yield of ripe fruit from the plants in each group. The results obtained, although vitiated to some extent by a disease which affected some of the fruit during the earlier part of the season, show quite clearly the effects of the chemical fertilizers. Plants to which raw bonemeal alone was applied gave an increase of fruit over that of the control plants of nearly 11 per cent. Nitrate of soda by itself failed in this instance to produce as good a crop as that of the control; a result quite the opposite of that obtained in the bench grown plants as shown in table V. The addition of muriate of potash or acid phosphate gave marked increases in the first instance of over 20 per cent. and in the last of nearly

TABLE XII.

Average number and weight of ripe fruit per plant from each group, Feb. 21 to May 9, 1899.

Number of group	Average number of fruits per plant	Average weight of single fruits	Weight of fruits per plant		Per cent. of increase over control	Fertilizers used
		grams	grams	ounces		
I	11.3	133.9	1514.	53.4	....	none.
II	13.	128.9	1676.	59.1	10.7	Raw bonemeal.
III	20.7	97.7	2023.	71.4	33.6	Acid phosphate, nitrate soda.
IV	13.	115.4	1499.7	52.9	—.9	Nitrate soda.
V	14.	130.2	1823.	64.3	20.4	Nitrate soda, muriate potash.
VI	14.	151.	2117.	74.7	39.8	Raw bonemeal, nitrate soda and muriate potash.

34 per cent. The best results were obtained from the complete fertilizer in group VI, from which an increase of nearly 40 per cent. was obtained.

Second Season. –The work of the second season was practially a repetition of that of the first. A slightly increased amount of fertilizers were used, and chemically pure substances of nitrate of soda and muriate of potash were substituted for the commercial forms. These with the addition of another group of plants were the only important changes made. The amounts of chemical fertilizers applied to each group are given in table XIII. In group II the amount of bonemeal applied to the soil was 41.095 grams, the same as in the previous crop. This amount was augmented on March 16 by an application through the sub-watering method of 20.5 grams. The increased application of nitrate of soda and muriate of potash came as a fifth and third application respectively of these ingredients.

Twenty-one plants instead of 16 were grown in this experiment. These were divided into seven groups of three plants each. The seed was sown nearly a month later, October 7, in order to avoid waiting for the greenhouse space, which during the earlier part of the season was devoted to chrysanthemums. The seedlings were potted off October 25, shifted to four inch pots November 18, and transferred to the zinc pots December 5. The first ripe fruits were picked February 17, and the last on May 4, or a fruiting period of 11 weeks being about the same duration as the preceding crop. The data presented in table XIV gives

TABLE XIII.

Fertilizers used in pot experiment, 1899-'00.

Number of group	Amount in grams per pot: Raw bonemeal	Acid phosphate	Nitrate of soda	Muriate of potash	Approximate amount in ounces
	grams				
I	none	none	none	none	....
II	61.6	none	none	none	Raw bonemeal 2.2
III	none	17.415	13.209	none	Acid phosphate .6
IV	none	none	13.209	none	Nitrate of soda .46
V	none	none	13.209	8.	Muriate of potash .28
VI	41.095	none	13.209	8.	....
VII	none	17.415	13.209	8.	....

the average yield of ripe fruits per plant from each group, also the per cent. of increase over the control. The results obtained

TABLE XIV.

Average number and weight of ripe fruit per plant from each group, Feb. 17 to May 6, 1900.

Number of group.	Average number of fruits per plant.	Average weight of single fruits.	Weight of fruits per plants in. grams.	ounces.	Per cent. of increase over control.	Fertilizers used.
		grams				
I	8.3	79.9	663.3	23.4		None.
II	14.	82.9	1161.3	40.9	75.1	Raw bonemeal.
III	18.	91.2	1642.	57.9	147.5	Acid phosphate, nitrate of soda.
IV	11.7	85.2	997.	35.2	50.3	Nitrate of soda.
V	13.3	82.4	1096.3	38.7	65.3	Nitrate soda, muriate of potash.
VI	24.	107.7	2585.7	91 2	289.8	Raw bonemeal, nitrate soda muriate potash.
VII	19.3	108.5	2095.	73.9	215.8	Acid phosphate, nitrate soda and muriate potash.

show a decided increase in product from all plants receiving chemical fertilizers. This increase even in group IV, to which nitrate of soda alone was applied is over 50 per cent. as against a slight gain in favor of the control plants in the preceding experiment. The acid phosphate and nitrate of soda combination again gave better results than the raw bone meal, an increase of over 147 in favor of the former, as against 75 per cent. in favor of the latter. As in the first season, the largest yield of ripe

fruits were obtained from the raw bonemeal, nitrate of soda and muriate of potash, an average of 5.7 pounds per plant being obtained, or an increase over the control of nearly 290 per cent.

SURFACE AND SUB-APPLICATION OF WATER AND LIQUID FERTILIZERS.

Third Season.—The work of the third season included a test of surface and sub-application of water and of liquid solutions of nitrate of soda and muriate of potash, and to some extent of acid phosphate. Six groups of four plants each were grown. The chemical fertilizers applied to the pots in each of these groups as given in table XV, show a marked increase of nitrate of soda and muriate of potash over preceding experiments. These amounts were greatly in excess of that contemplated at the outset, and were the result of more frequent applications during the growth of the plants. Chemically pure substances of nitrate of soda, muriate and sulfate of potash were used. Five grams of the nitrate of soda was applied to the soil

TABLE XV.

Fertilizers used in pot experiments 1900-'01.

Number of group.	Amount in grams per pot					How applied.
	Raw bonemeal.	Acid Phosphate.	Nitrate of soda.	Muriate of potash.	Sulphate of potash.	
I	none	none	none	none	none	
II	42.525	5.	23.290	12.	none	sub.
III	42.525	5.	23.290	12.	none	surface.
IV	42.525	5.	23.290	none	14.306	sub.
V	none	35.435	23.290	12.	none	sub.
VI	none	35.435	23.290	12.	none	surface.

previous to setting the plants, the balance being applied in liquid form in five equal amounts during the fruiting period of the plants. In the case of the potash compounds, one-fourth the amount was applied to the soil before the plants were set, the balance being applied in three equal amounts during their growth. A solution of five grams of acid phosphate was applied to the plants as late as May 11. This application was made in order to insure an abundance of phosphoric acid in the soil, to mature all the fruit set.

Plants of Sutton's Best of All, in four inch pots, were transferred to the zinc pots Dec. 4, 1900. The first ripe fruits were gathered Feb. 18, and the last on June 7, a bearing period of

over 15 weeks, as compared with about 11 weeks for the two preceding crops. The data obtained from the crop which is given in tabulated form in table XVI, shows a surprisingly low yield from the control plants in group I. This would indicate that the soil used was lacking in soil fertility, at least in available plant food. Owing to this condition of the soil, the per

TABLE XVI.

Average number and weight of ripe fruits per plant from each group, Feb. 18 to June 7, 1901.

Number of group.	Average number of fruits per plant.	Average weight of single fruits.	Weight of fruits per plant in.		Per cent. of increase over control plants.	Fertilizers used.
			grams	ounces		
		grams				
I	7.8	80.7	473.8	16.7	....	None.
II	25.5	105.9	2700.8	95.2	470.	Raw bonemeal acid phosphate. nitrate soda and muriate potash.
III	24.8	95.5	2369.3	83.5	400.	Duplicate of II, surface applica tions.
IV	22.5	113.5	2553.	90.	438.9	Duplicate of II, sulfate of potash substituted for muriate.
V	21.	107.8	2264.5	79.9	377.9	Acid phosphate, nitrate of soda and muriate of potash.
VI	26.5	104.7	2774.5	97.9	485.6	Duplicate of V, surface applications.

cent. of increase over the control is very much greater than in either of the two preceding crops. Comparing the product of the surface and sub-watered groups of plants, it is found that in groups II and III, or the raw bonemeal series, there is a decided gain in favor of the sub-watered plants. If however, we compare groups V and VI, the advantage is largely in favor of the surface watered plants, that is to those receiving their moisture and liquid applications of fertilizers on the surface of the soil. Taking the combined average product of the two surface and two sub-watered groups, we find that there is an increase of about 3.5 per cent in favor of the surface watered plants. A comparison of groups II and IV shows that the muriate of potash gave a larger increase than the sulfate of potash. This increase amounted to nearly six per cent.

SUMMARY OF POT EXPERIMENTS.

As in the case of the bench grown plants, an attempt has been made to correlate the essential features brought out by the three crops grown in pots. As the number of plants grown in each group varied from two to four, comparisons will be made on the basis of the average weight of ripe fruit per plant rather than from the total product per group. The product of the surface and sub-watered plants in the last crop are given in the two groups of complete fertilizers. The late application of acid phosphate to plants in the third crop is ignored, on account of its being given to all plants receiving fertilizers. Outside of these variations the comparisons made are believed to be equally fair for all. As in the bench grown plants, those of the control are taken as the basis of comparison for the percentage of increase, assuming the average yield of the three control crops to be the normal product of the soil.

TABLE XVII.

Yield of fruits per plant from different chemical combinations.

Fertilizers applied.	Season of 1898-'99.	Season of 1899-'00.	Season of 1900-'01.	Average product per plant.
	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
None	3.5	1.7	1.1½	1.15
Nitrate of soda	3.5	2.3	....	2.12
Nitrate of soda and muriate of potash	4.	2.7	....	3.4
Nitrate of soda and acid phosphate	4.7	3.10	....	4.1
Nitrate of soda, acid phosphate and muriate of potash	....	4.10	5.9	5.4
Nitrate of soda, raw bonemeal and muriate of potash	4.11	5.11	5.13	5.8
Nitrate of soda, raw bonemeal and sulfate of potash	....	....	5.6	5.6
Raw bonemeal	3.11	2.9	....	3.2

In fertilizer combinations, in which only one or two crops are grown, the average yield of the controls representing them are considered. Thus the nitrate of soda group includes the first two crops, hence the yield of plants from these controls will be taken as the normal product of the soil used. In this instance the addition of nitrate of soda gave an increase of nearly 16 per cent. Nitrate of soda and muriate of potash for the same crops

gave an increase of over 35 per cent. A combination of nitrate of soda and acid phosphate increased the crop nearly 70 per cent. The addition of muriate of potash to the nitrate of soda and acid phosphate group produced an increased yield over their respective controls of over 325 per cent. The substitution of raw bone meal for the acid phosphate, in the succeeding data, gave for the three crops an increase of over 185. per cent. and for the last two crops, or those comparable with the acid phosphate, of over 345 per cent. The substitution of sulfate for muriate of potash in the last group and crop did not give quite as large a yield, and as the product from the control plants was so small, no just comparison can be made with the preceding group. The application of raw bonemeal alone increased the product to about 32 per cent. or nearly as much as from nitrate of soda and acid phosphate.

A comparison of the average product of plants from the two groups of complete fertilizers in which acid phosphate and raw bone meal were used, shows a slight gain in favor of the raw bonemeal. The average yield per plant from the raw bonemeal series was 5.8 lbs. as against 5.4 lbs. for that of the acid phosphate group.

MONEY VALUE OF CROP.

The winter forcing of tomatoes is only second in importance to that of lettuce as a winter forcing vegetable. As with all other perishable hothouse products the prices are governed largely by the season, the supply and the demand. As a rule the prices range from twenty to seventy-five cents per pound. The latter figure however, is rarely obtained at the present time. The writer, however, assisted in growing a crop of winter tomatoes during the winter of 1887-'88, a part of which wholesaled to a Boston commission house at one dollar per pound. The year previous to that a consignment or two of fruit from the same houses wholesaled in Boston at one dollar and a quarter per pound. So far as known the above figures are the highest wholesale prices ever received for tomatoes, at least in recent years, in this country. The average selling price at the present time is probably between twenty and forty cents a pound. The money value of the crop depends upon two factors, the prices received and the yield of fruit in pounds per square foot of space occupied. In the ensuing discussion these factors will be considered in relation to our own work.

Bench Crops.—The bench upon which these crops were grown was 19 ft. long by 3 ft. 9 in. wide, but on account of its proximity to the glass, about a foot at the back side, it only permitted of setting one row of plants, which had to be trained upon a roof trellis. Owing to this fact a bench of one half the width, or say two feet in width, would have served the same purpose. Hence we may say that to all intents and purposes 38 square feet of bench surface would have met the requirements of the plants provided six to seven feet of head room had been available.

Yield and Prices.—In considering the yield of the plants in each of the three crops grown, those to which a complete fertilizer was applied will be taken to represent the total yield from the whole bench. In the case of the third crop, owing to the excessive application of fertilizers to sections III and IV, (see table VIII) the product from the plants in section II will be taken as the basis of yield from the whole bench. A uniform price of twenty cents per pound was obtained in LaFayette for all the fruit grown.

The total yield from each of the three crops grown on the basis mentioned and the price received, which is presented below, shows a considerable degree of uniformity.

	Number of pounds.	Price per pound.	Value of crop.	Amount per square foot.
First crop....... .	129	$.20	$25.80	$.68
Second crop....... ..	118	.20	23.60	.62
Third crop........ ..	113	.20	22.60	.59

Assuming the yield in pounds per square foot occupied to be the true basis of comparison for commercial purposes, we find that the first crop gave an average of 3.4, the second 3.1, and the third 3 pounds per square foot, at the price obtained, twenty-cents, this represents a money value of sixty-eight, sixty-three, and fifty-nine cents per square foot.

Pot Grown Plants.—In the pot grown plants only those to which a complete fertilizer was applied will be taken into consideration. As these plants were grown in ten inch cans it will be necessary to take into consideration the distance apart of the plants in computing the area occupied by them. The cans were ranged in rows about one foot apart with a space of about two inches between the cans in the row. This would represent an area of about 12x22 inches or 1.8 square feet.

Yield and Value.—As but one plant was grown in a ten-inch can, the average yield of the plants grown by the aid of

complete chemical fertilizers will represent the product from the given area occupied by the plant.

	Number of pounds ounces.	Price per pound	Value of .crop	Amount per square foot.
First crop............	4.11	$.20	$ .94	$.52
Second crop..........	5.3	.20	1.04	.58
Third crop...........	5.10	.20	1.13	.63

The data presented shows an average yield of about 2.6, 2.9 and 3.2 pounds per square foot from the first, second and third crops respectively, or an income per square foot, at the prices obtained of 52, 58 and 63 cents. These results are somewhat lower than those obtained from the bench crops. The average return from the three crops of bench grown plants was 63 cents as against 58 cents for the pot grown ones. It must be remembered, however, that only one crop was grown during the season, while commercially it is customary to grow two. The reason for only growing one crop was in order to permit of a more careful test of the effect of the chemical fertilizers applied, by allowing all the fruit to mature that was possible, also the space occupied by the pot plants was devoted to chrysanthemum culture till about the first of December.

Mr. A. T. Jordan, *reports an average cash return per crop based on prices received for three seasons, of two crops each, of 33.74 cents per square foot or a total average income per season of 67.5 cents.

Prof. Bailey **says:—"A winter crop to be profitable should average at least two pounds to the plant in close planting and single-stem training, and a spring crop should average four pounds to the plant."

In general it may be stated that when properly grown, and disposed of at a fair average price, the tomato is probably as profitable a winter forcing vegetable as is that of lettuce or cucumbers. To be grown successfully it requires a temperature of from 60-65 degrees Fahrenheit at night with a rise of 10-15 degrees during the day. If desired they may follow a crop of chrysanthemums or lettuce for an early spring crop.

*Jorden, A. T. Twentieth Ann. Rep. N. J. Agr. Exp. Sta., p. 174, 1899.

**Bailey, L. H.—"The Forcing Book," pp. 160-170, 1897.

RELATION OF THE PER CENT OF SMALL FRUIT TO CHEMICAL FERTILIZERS APPLIED.

In order to study the relation of food supply to the size of the mature fruit produced, special tables have been prepared in which all ripe fruits weighing less than fifty grams (nearly 2 ozs.) are classified as small fruits. It is assumed that fruits weighing less than fifty grams are too small for marketable purposes. The data presented has been taken from both the bench and pot grown plants. Separate tables have, however, been compiled for each. The percentages given are based on the relative weight of the small fruits to that of the total product. The data from the

TABLE XVIII.

Bench Grown Plants.

Fertilizers used.	First season.		Second season.		Third season.		Percentage small fruit.		
	Number of fruit.	Weight in grams.	Number of fruit.	Weight in grams.	Number of fruit.	Weight in grams.	First	Second	Third
None	20	736.	6	230.	......	......	9.3	2.7	....
Nitrate soda.	8	322.	3	130.	......	......	3.1	1.3	....
Nitrate soda and acid phosphate..	12	307.	1	30.	......	......	2.8	.2	....
Nitrate soda, acid phosphate and muriate potash.....	11	342.	2	68.	31*	1129*	2.3	.5	4.
Acid phosphate, muriate of potash........					8	313			3.2

*Total number of small fruits from sections II, III and IV, with weight of same.

bench grown plants is given in table XVIII, while that of those grown in pots is presented in table XIX. It was found that in all instances save one, the control plants produced by far the larger proportion of small fruit. In general, the proportion of small fruits decreased according to the completeness of the plant food supplied. For example in the first crop of bench grown plants, those receiving no fertilizers yielded 9.3 per cent of small fruit, plants receiving nitrate of soda had 3.1 per cent. those receiving nitrate of soda and acid phosphate 2.8 per cent, while from plants to which applications of nitrate of soda, acid phosphate and muriate of potash were made, only 2.3 per cent.

TABLE XIX.

Pot Grown Plants.

Fetilizers used.	First crop.		Second crop.		Third crop.		Percentage small fruit.		
	Number of fruit.	Weight in grams.	Number of fruit.	Weight in grams.	Number of fruit.	Weight in grams.	First crop.	Second crop.	Third crop.
None	2	87.	8	69.	13	384.	1.7	13.3	20.3
Nitrate soda.	1	25.	7	281.	......	......	.5	8.7	....
Nitrate soda, acid phosphate......	8	262.	10	327.	......	......	3.9	6.6	....
Nitrate soda, acid phosphate and muriate potash.....	......	......	3	88	10†	323†	......	1.1	1.6
Nitrate soda, raw bonemeal and muriate of potash ...	0	0	5	200.	18‡	633‡	0	3.5	3.1
Raw bonemeal	2	63.	6	181.	......	......	1.1	5.	....

†Number of small fruits from groups II and III.
‡Number of small fruits from groups V and VI.

by weight was classified as unmarketable. These results were with one exception corroborated in the second and third crops, though not to such a marked extent as in the first. The pot grown plants showed very similar results except in the first crop, in which plants receiving nitrate of soda and acid phosphate had 3.9 per cent of small fruit as against 1.7 per cent, from the control plants. This is the only instance in the whole set of experiments in which fertilized plants showed a greater percentage of small fruit. A general consideration of the foregoing data shows that the relative yield by weight of small fruits is larger from plants grown on soil not fully supplied with plant food, and that this proportion decreased in a fairly uniform ratio according as the needs of the plant are supplied.

CHEMICAL FERTILIZER EXPERIMENTS BY OTHER STATIONS.

Chemical fertilizers as an adjunct to, or a substitute for, stable manure has been employed to a greater or less extent in the winter forcing of tomatoes, by a few of our experiment sta-

tions.* Of those which have come to the attention of the writer, the work which has been done by the Connecticut Station embraces by far the most exhaustive study of the subject. The study includes a test of the effects of various chemical combinations, upon the production of fruit; varying amounts of fertilizers; analysis of the plants and fruit to determine the relation of the amount of fertilizers applied to the soil, to that contained in the plant; comparative tests of plants grown in rich compost, with and without fertilizers, with those grown in a mixture of coal ashes and peat moss to which chemical fertilizers had been applied.

The conditions under which the greater part of the foregoing work, as well as those referred to in the footnotes, were performed, vary sufficiently from those of our own to preclude any close comparison of the results obtained. In all of the experiments performed comparisons were made between plants growing in a rich compost soil, with or without commercial fertilizers and an artificial compost of coal ashes and peat with chemical fertilizers. In our work a soil was used which was known to be deficient in plant food. Plants were grown in this soil with and without chemical fertilizers and comparisons made between the resultant crops.

In the main, however, the experiments agree in this point, that a profitable crop of tomatoes may be grown by the use of chemical fertilizers alone. In all of the Connecticut experiments the product from the plants grown in coal ashes and peat, with chemical fertilizers, exceeded that from plants grown in rich compost either with or without fertilizers. This was corroborated by the experiments of the New Jersey Station in the case of the surface watered plants.

RELATIVE PROOUCTIVENESS OF THE "STONE" AND "SUTTON'S BEST OF ALL" TOMATO.

In the last crop of tomatoes grown on the bench, two plants of each variety were grown in each of the sections. Plants of the two varieties were grown alternately with each other from one end of the bench to the other. As careful records were kept

*Mass. Agr. Exp. Sta. bull. 10, p. 5, 1890
Conn. Agr. Exp. Sta., Nineteenth Ann. Rep't, 1895, pp. 75-92; Twentieth Ann. Rep't, 1896, pp. 205-221; Twenty-first Ann. Rep't, 1897, pp. 278-293; Twenty-third Ann. Rep't, 1897, pp. 219-224.
N. J. Agr. Exp. Sta., Twentieth Ann. Rep't, 1899, pp. 160-175.

on the yield of ripe fruits from each plant, the relative number and weight of fruit from each variety was easily obtained. As the plants of each variety duplicated each other in the four sections, table XX has been prepared in which the product from the eight plants in each group is given. The result obtained shows a

TABLE XX.
Total number and weight of ripe fruits.

Variety grown.	Total number of ripe fruit.	Total weight of ripe fruit in grams.	Approximate weight in pounds .	Average weight of fruit.	Per cent. of increase.
Sutton's Best of All	238	19960	44. lbs	3 ozs.	..
Stone	178	20310	44.8 lbs	4 ozs.	3.3

larger number of fruit from Sutton's Best of All, 238, as against 178 from the plants of Stone. In the total weight of fruit the Stone slightly exceeds that of Best of All, the increase being a little over three per cent. The average weights of the fruit are three ounces for Best of All as against four ounces for Stone.

While the above results indicate the Stone to be slightly superior to "Sutton's Best of All" in that the fruits are considerably larger, being as four is to three, the weight of the product is practically the same. As a rule the number of rough fruit was greater in the Stone. From results obtained from pot experiments, it is believed that Best of All is better suited to this line of work than is the Stone.

SURFACE VERSUS SUB-WATERING.

The question as to the best method of applying water to plants grown in benches is one which has recently been considerably agitated. While the sub-watering method is a comparatively new one in its indoor application to growing crops, it nevertheless is slowly gaining more advocates among commercial growers. It is believed that as its merits become better known it will more and more supplant the old method of surface watering.

In order to further test the merits of these two systems of watering, a small bench was especially fitted up in the fall of 1898. The bench which was divided into equal compartments, was covered with a water tight zinc pan four inches in depth. An overflow two inches from the bottom, a glass water gauge, and a zinc tube through which to fill the pan with water, completed the

equipment. The pan was filled with brick in the same manner as described in the preceding pages of this report.

Soil Used.—The soil used in the bench consisted of a fairly well decomposed black loam sod, to which had been added about one-fifth of its bulk of manure.

Plants Grown.—Plants of the Lorillard variety were used, four plants being grown in each section. These were handled in the same manner as those in the fertilizer experiments and were planted out from four inch pots Nov. 9, 1898. They were grown with a main stem and two laterals.

Watering.—Water was applied to the two sections as the soil seemed to demand it. The plants in the sub-watered section made a slightly better growth than the surface watered ones, and apparently required a greater amount of water. It was found as the experiment progressed that a loose friable soil, such as one consisting of rotted sod and manure, which has not been screened, is not a suitable soil to absorb moisture by capillary attraction. It was with the greatest difficulty that sufficient water could be applied from below to keep the soil near the surface at all moist. On the other hand the loose friable nature of the soil proved well adapted to surface watering, especially when in a bench construted for sub-watering, where all the extra moisture passing through the soil was absorbed by the brick to be again returned to the plant.

Comparison of Yield.—As the yield of fruit from the plants is the chief point of issue between the two systems in this case, a comparison of the results obtained should prove of some interest. As in the preceding experiments, weights were made of the individual fruits from each plant. In the following table XXI, are given the total number and weights of fruits from the plants in each section. Comparing the total number of fruit

TABLE XXI.

Number and weight of fruit from surface versus sub-watered sections.

Section.	Total number of fruits	Total weight of fruits.	Average weight of fruits.	Per cent. of increase.
Surface watered...	87	10122 grams	116.3 grams	
Sub-watered	85	10778 grams	126.8 grams	6.5

from each section we find it to be slightly in favor of the surface watered section. On the other hand the average weights of the

fruits are considerably in favor of the sub-watered section. These results are entirely in accordance with previously accepted conclusions regarding the relation of the number and size of the fruit to the vigor of the plant. That is, the more vigorous the plant from superior cultural conditions, the less the number, but the larger the fruit obtained.

The increase in total product from the sub-watered section over that of the surface watered one, was about 6.5 per cent. This increase though apparently but a slight one, is nevertheless quite satisfactory when we consider that the soil used was not adapted to sub-watering on account of its porosity.

SUMMARY.

The conclusion that may be derived from the preceding data may be summed up as follows:

(1). Chemical fertilizers are capable of causing the production of a large increase of fruit from the vines.

(2). Nitrate of soda alone may cause an appreciable gain in product, but this increase is much improved by the addition of acid phosphate and muriate of potash.

(3). Nitrate of soda combined with acid phosphate causes a much larger increase than when combined with muriate of potash.

(4). Raw bone meal alone gave nearly as good results as nitrate of soda and acid phosphate.

(5). As a rule raw bonemeal when combined with nitrate of soda and muriate of potash, gave slightly better results than did acid phosphate in combination with these materials.

(6). The relative percentage of small fruits were greater from plants which were grown in soils imperfectly supplied with plant food than from those having an abundant food supply.

(7). Larger fruits with but a slight increase in product, were obtained from Stone as compared with Sutton's Best of All.

(8). With the conditions wholly in favor of surface watering, the sub-watering method proved the superior of the two.

(9). Soil containing a large percentage of fibrous material such as rotten sod, is not well adapted to supplying moisture by capillary attraction. To secure the best results in sub-watering, the soil should be screened and made reasonably firm in the bench.

TOMATOES IN POTS.

Photograph illustrating method of growing tomatoes in zinc pots, also device for sub-watering. Photographed Feb. 16 1900.

THE PHYSIOLOGY OF MILK SECRETION.

By A. W. Bitting, M. D., D. V. M.

In reproduction among the higher animals, the offspring at birth are not sufficiently matured to be able to subsist alone; neither are they surrounded by food that is already prepared for them. It is therefore necessary that Nature should provide for a part or whole dependence upon the mother for subsistence, during such time as is required for development to a state capable of independent existence. As a means to this end we find a mammary gland in a very large group of animals, the secretion from which is known as milk, and is a perfect food. Milk contains all the nutriment required by a growing body, in proper proportions, in a palatable and easily digestible form. For these reasons persistent efforts have been made to domesticate animals and develop this function to the hightest degree as a source of food for people. How successful these attempts have been, is exemplified in the milking capacities of several animals now used for this purpose. Animals in a wild state furnish a quantity of milk only sufficient for the young, and only for such time as is necessary for their maintenance. Under domestication, the cow in particular, has been developed to produce a quantity sufficient to support several offspring, and to keep up the secretion almost continuously.

The mammary gland being an accessory organ of generation, it is but natural that it should be rudimentary at birth and without function. It remains in this condition until the reproductive function becomes active, at which time it begins to develop quite rapidly, and continues to do so until the end of the first period of gestation. Like other organs of the body, it grows with the general growth, and from usage. Its functional activity does not ordinarily begin until near the close of the period of gestation, reaches its maximum at from ten to fifteen days thereafter, and then gradually declines and practically ceases in from six to ten months. If the gland should be examined at birth, a whitish fluid will be found in the ducts, but it is not true milk. True milk may occur however, at a very early date, and without the stimulus of pregnancy. A case as follows came under the notice of the writer. A farmer gave a young calf to his son to feed and care for. The little fellow began going through the motions of milking his pet, and in the

course of a few weeks surprised his father by producing a half pint of milk. While this is an exceptional quantity for a young calf, the observation has frequently been made that small quantities will be present in the udders of calves that suckle each other while being weaned. Gabby reports the case of a heifer that had never showed signs of oestrum, suddenly developing a large udder and was milked constantly for three years.

The male is possessed of a rudimentary mammary gland, but the writer is not aware that it ever developes functional activity under any form of stimulus in the lower animals.

THE CHARACTERISTICS OF MILK.

The first secretion of the mammary gland before or immediately after birth, is an acrid, viscous, yellowish fluid, having a slightly alkaline reaction, and a specific gravity greater than water. It is called colostrum, and immediately precedes the true milk secretion. Colostrum differs from milk in that it contains a higher per cent of total solids, largely of an albuminoid character, also in the abundance of mineral salts. The albumenoid substance is present in the form of small organized bodies varying in size from a small fat globule to five or six times the size of the large fat globules and are known as colostrum corpuscles. These colostrum corpuscles are the cells which have been lying quiescent in the alveoli of the gland. Upon the sudden development of functional activity in the gland, these are swept away. The increased albuminoid content is so marked that it may be detected by simply heating, as well as by the more delicate chemical methods. The fat, the casein and milk sugar are present in less quantity than in normal milk. The taste is slightly acid, the odor strongly animal and sometimes putrescent. The effect upon the body is as a mild cathartic. The transtion from colostrum to milk is gradual, requiring from three to six days. If a cow be milked constantly, no colostrum, or only a slight quantity, will be present, showing that it is the result of the resting of the cells, and not a special product.

Milk is the normal secretion of the mammary gland. It is a true emulsion, an opaque, bluish white or yellowish white liquid, slightly heavier and more viscous than water, is nearly neutral, possessed of a slight animal odor and a pleasant sweetish taste.

The odor of milk is due to the extremely small particles of

fat, casein and insoluble ash held in suspension. Each species of animal has its peculiar odor, and in addition it may be affected to some degree by the feed. The fat gives the yellowish tint and the caseine and ash the opalescent appearance. By many, yellowishness is regarded as an indication of richness. While yellowish milk is usually rich, it does not necessarily follow that white milk may not be rich. The yellowish character is to a certain extent also a breed characteristic. The bluish color has the effect of neutralizing the yellow and making the whole have a whiter appearance than it otherwise would.

The specific gravity of milk varies from 1.029 to 1.035, the average being 1.032. The variation is with the per cent of total solids present and not with the per cent of fat. A very high per cent of fat will have the effect of lowering the specific gravity, but the relation between the specific gravity and fat is not sufficiently close to warrant using the former in estimating the latter.

The viscosity of milk is greater than that of water, on account of the character of the solids it contains, and especially upon the state of aggregation of the fat globules.

The reaction of milk is variable. The milk of the herbivora is generally described as normally alkaline, but at times it is also said to be possessed of an amphigenic reaction, that is both alkaline and acid. In 1892, Professor Huston of this Station, made a series of experiments to determine the reaction of milk, and obtained an acid reaction in all cases. His method differed from those usually described and is as follows: To 25 c. c. of milk, 5 c. c. of normal H. Cl. solution was added to get a positive acid reaction, then titrating with a one-half normal potassic hydrate solution until a neutral reaction occurred. In freshly drawn milk (28 samples) it required .01648 c. c. of normal potassic hydrate to neutralize 1 c. c. of warm milk, or .01694 c. c. to neutralize the same quantity of cooled milk. The acidity of milk after standing, is from changes which it undergoes through bacterial fermentation.

The milk of all animals shows essentially the same constituents, and analysis shows that these apparently differ only in the relative proportion of the several constituents present, a condition analagous to the body fat.

The composition of milk is of a very complex character. It consists of a mixture containing water, proteids, carbohydrates, organic and inorganic acids, and animal salts. Minute

quantities of ammonia, urea, hypoxanthin, chyme, chyle, biliverdin, cholestrin, mucin, lecithin, kreatin, leucin and tyrosin are sometimes present.

A much used classification is as follows: Water, fats, albuminoids and ash. All the constituents taken together, except the water are known as milk solids. These comprise from 12 to 15 per cent. of the total. Viet complied the results of 120,540 analyses covering a period of eleven years and found the average per cent. of solids in milk to be as follows:

Total solids	12.9
Solids not fat	8.8
Fat	4.1

The solids exist in milk in solution, in semi-solution and in suspension. Analyses of cows milk are given in table XXII.

TABLE XXII.

Analyses of Cow's Milk as Quoted by Wing.*

Substances	American (Babcock)	English (Oliver)	German (Fleischman)	French (Cornevin)
Water	87.17	87.60	87.75	87.75
Fat	3.69	3.25	3.40	3.30
Casein	3.02	3.40	2.80	3.00
Albumen	.55	.45	.70	.....
Sugar	4.88	4.55	4.60	4.80
Ash	.71	.75	.75	.75

*Milk and its Products. H. H. Wing, 1897.

Peter Collier of the New York Experiment Station made analyses of milk during one entire period of lactation, from several breeds of cows, with the following results:*

*New York Experiment Station, Rept. 1891.

TABLE XXIII.

Analyses of Cow's Milk as Given by Collier.*

Breed	Number analyses	Water	Total solids	Solids not fat	Fat	Casein	Milk sugar	Ash	Nitrogen	Daily yield
Holstein...	132	87.62	12.39	9.07	3.46	3.39	4.84	.735	.540	22.65
Ayrshire..	252	86.95	13.06	9.35	3.57	3.43	5.33	.696	.543	18.40
Jersey.....	238	84.60	15.40	9.80	5.61	3.91	5.15	.743	.618	14.07
American Holderness	124	87.35	12.63	9.08	3.55	3.39	5.01	.698	.533	13.40
Guernsey..	.....	85.39	14.60	9.47	5.12	3.61	5.11	.753	.570	16.00
Devon.....	112	86.26	13.77	9.60	4.15	3.76	5.07	.760	.595	12.65
Average...	72	86.37	13.64	9.40	4.24	3.50	5.05	.731	.534	16.20

*New York State Experiment Station, Rept. 1891.

According to Koenig, the limits of variation as collected from about 800 analyses taken from all parts of the world are as follows:

	Maximum.	Minimum.
Water	90.69	80.32
Fat	6.47	1.67
Casein	4.23	1.79
Albumen	1.44	.25
Sugar	6.03	2.11
Ash	1.21	.35

While the range of variation seems considerable, some of the constituents, notably that of the fat, may show even greater variation, in milk secreted by normal, healthy cows. Babcock found the milk of a single cow giving a small quantity, contained as high as 10 per cent of fat. He further states that no analysis showing more than 9 per cent of fat is recorded from a cow giving more than 15 pounds of milk per day.

When milk is examined under the microscope, it appears as a clear liquid in which are suspended an immense number of spherical bodies that are of a light yellowish appearance and are highly refractive. These constitute the fatty part of the milk and are known as milk globules. Their small size and the viscuous

nature of the milk serum, tend to prevent the coalescence of the globules. The size of these globules varies in all milks, varying from 2 mmm. up to 30 mmm. in diameter (1 mmm. equals 1—25,000 of an inch). The size also varies with the milk drawn, whether it be the first, middle or last drawn, as may be seen by the following records given in table XXVI.

TABLE XXIV.

Number of Globules of Each Size Per Thousand Globules,

Size in Mu's	1st milk	Middle milk	Last milk	Whole milk	Skim milk
4	95	18	68	70	365
6	220	90	153	190	425
8	427	215	238	319	120
12	152	443	204	180	54
16	67	180	127	121	24
20	20	54	85	76	12
24	10	00	25	19	...
28	9	00	00	...	...

As the period of lactation advances the globules increase in number and the average size diminishes, so that after several months the total number of globules per cubic centimeter may be two or three times as great as at first, but the size correspondingly smaller and the per cent of fat approximately the same.

P. Collier records* the results of a large number of determinations of the size of the globules in the milk of different breeds. The size of the globules diminishes as the period of lactation advances, that is the relative number of large globules diminishes and the smaller globules increase. He found** that the relative number was 100 in the first quarter, 137 in the second quarter, 149 in the third quarter, and 187 in the fourth quarter of the period of lactation. That is a given quantity of milk contained

*New York Experiment Station, Report, 1891.

**Experiment Station Record, Vol. V. p. 95.

89 per cent. more fat globules in the last quarter than in the first.

O. Schnellenberger* found essentially the same thing, and estimated that a liter of milk contained 2480 millions of globules at the beginning and 4449 millions of globules at the end of the period of lactation.

F. W. Woll agrees with the previously cited writers and further adds that age has no apparent effect, and that the morning milk contains more large globules than the evening milk.

The milk from certain breeds, as the Jerseys and Guernseys, is characterized by large globules, while that of other breeds, as Ayrshires and Holsteins, usually contain small globules. There is, however, a wide individual difference in all breeds, Jerseys sometimes producing small globules and Holsteins large ones. In normal milk the globules are uniformly distributed throughout the whole mass, but to a greater or less extent collected in groups. For a long time it was thought that each cell was surrounded by its own membrane, the membranes of Acherson. This membrane was supposed to be derived from the cell of protoplasm. According to Babcock no such membrane exists, and he is supported in this view by nearly all recent investigators. It is now considered that milk is a natural emulsion, and that what appears to be a membrane is not different from what is seen in other emulsions, having the fat similarly divided.

The fat of milk is very complex, being a mixture of six or eight distinct fats, some being volatile and others not. The following in Table XXV. is the composition submitted by Wiley.**

TABLE XXV.

Composition of Butter.

INSOLUBLE FATS.			
Olein	42.21	Oleic acid	40.40
Stearin and palmatin	50.00	Stearic and palmic acid	47.50
	92.21		87.90
SOLUBLE.			
Butyrin	4.67	Butyric acid	3.49
Caproin	3.02	Caproic acid	2.40
Caprylin and Rutin	.10	Caprylic acid and Rutic acid	.80
	7.79		6.69

*Experimental Station Report, V. P. 95.

**Principles and Practice of Agricultural Analysis. H. W. Wiley, 1897.

The insoluble solids constitute a little more than 92 per cent of the total fat, are stable and suffer little from the organized ferments. They are tasteless and nearly neutral. They are composed of glycerol united with fatty acids. The peculiarity of these fats, lies in the proportion of the different ones present. The presence of a greater proportion of stearin raises the melting point, while a high proportion of olein lowers it.

The proportion of these fats is fairly constant, but in the case of feeding cotton seed meal to cattle, the melting point of butter is raised and would seem to indicate that the per cent of stearin was increased. No analyses are available to determine. whether this is the case or not.

The volatile fats constitute less than eight per cent of the total fats in milk, but they are of great importance as they impart the taste and odor, and give the peculiar animal characteristics. They are probably more easily affected than any other constituent of the milk.

The casein is the chief proteid constituent of milk. It is insoluble in water and exists in milk in a semi-colloidal condition. It differs from other proteids in that it is coagulated by rennet and dilute acid, but not by heat.

Albumen is the soluble proteid of milk, and is similar to blood albumen. It is coagulated by heat when subjected to a temperature of 175 to 180 degrees Fahr.

Lactose or milk sugar is a carbohydrate peculiar to milk, as it is found nowhere else. It differs from cane sugar in that it is less soluble in water, has less specific gravity, only a slightly sweetish taste, does not readily undergo alcoholic fermentation, but is easily broken up by lactic acid forming bacteria.

Babcock and Russell have demonstrated that milk also contains an organized enzyme, which will cause slow changes upon standing. Their studies have not been continued for a sufficient length of time to give it a full description.

The organic acid is citric acid, and probably exists most often in combination with calcium and potasium.

The ash or inorganic constituents of milk represent less than one per cent. They exist in compounds of sodium, magnesium, calcium, iron and phosphorus.

These salts exist in soluble and insoluble states. The soluble salts are sodium chloride and potassium citrate, and the insoluble phosphates of magnesium, calcium, potassium and iron.

It is also of interest to note in this connection that the inor-

ganic matter in milk exists in the same relative proportions as in the new born. The salts in milk do not exist in the same relative proportion as in the blood which also tends to disprove the theory so long maintained that the separation of milk is largely a process of transudation.

QUANTITY AND QUALITY OF MILK SECRETED.

Wild animals secrete only a sufficient quantity of milk to meet the needs of their young until they become sufficiently developed to secure their own food. Under the influence of domestication the functional activity of the gland has been greatly developed both in the quantity produced and in the duration of the period of lactation. In all good dairy cows the period should extend over several months, and in some it is practically continuous. The average yield per cow is less than 4000 pounds per annum, but in good dairies it is more nearly 6000 pounds, and in individuals it will greatly exceed that amount. In one instance it was over 30,000 pounds.

The flow of milk is greatest shortly after parturition and gradually decreases until the close of lactation.

As milk is dependent upon the metabolism of the mammary gland, this is in turn dependent upon the quantity of blood passing through it. For large milking capacity it is necessary that there should be large glandular development, but more important still, a large circulation of blood in the part. The cow must receive an ample supply of food and have the capacity to eat, digest, assimilate and turn into blood the elements necessary to form milk. Some time after parturition there is a tendency toward a shrinkage of the vessels of the udder, and this becomes more marked as the period of gestation advances. All the excess nutrition of the body is needed for the developing foetus, and hence a lessening of the functional activity of the gland. That pregnancy is an influence tending to diminish milk secretion is demonstrated by the fact that spayed cows will continue to produce milk a long time, even two to five years, during which time the quantity and quality make a very gradual decrease. While pregnancy has its influence upon the period of lactation there are other factors that are of even greater importance and cannot be overlooked, the most important of which is the regularity and thoroughness of the emptying of the gland. If the milking process be done at irregular intervals or incompletely, the activity

of the gland soon ceases. Shortage of feed or water, or disease may result in immediate cessation of secretion. The ordinary period of lactation is from nine to ten months throughout the life of the animal. The first and second periods are somewhat shorter.

The quantity and quality of milk secreted each day is fairly constant. Variations do occur within certain limits and may be due to numerous causes. In general, the evening milk contains about a half per cent more fat than morning milk, but the latter exceeds the former by about 25 per cent in quantity. An attempt has been made to explain this by attributing it to the fall in temperature during the night, requiring some of the fat to keep up the body heat and to the lessened activity of the animal. Fleischmann and Vieth experimented upon a German herd of 119 cows, and found that the fat in the evening milk not only varied within wider limits than in the mornings' milk, but also observed that from March until July, the period of greatest activity of the gland, that the morning milk was richer in fats than the evening milk. The difference in the quantity of milk drawn morning and evening is due in part to the greater length of time allowed to elapse between the evening and morning milking. This may possibly also account for some of the differences in the percentage of fat. In general, the milk richest in fat is that drawn after the shortest period, and this has been shown to be true in cases where cows have been milked three or four times a day. After the third or fourth week of lactation the percentage of fat in the milk remains nearly constant until the seventh or eighth month, or until the quantity of milk begins to rapidly diminish.

The daily variations in the milk are sometimes considerable. Such variations may be ascribed to changes in the weather, temperature, food, surroundings, indisposition, etc.

The monthly variations in the quantity and quality of the milk are less marked, than the daily variations. Cows coming fresh in the spring, rapidly better the quality of their milk, beginning about five months after calving, but cows coming in in the fall maintain a fairly even quality throughout their entire period of lactation. The quantity of milk is augmented when cattle are first turned out to pasture and during drouth, but this must be ascribed to food conditions, and not to seasonal variation. The richest milk is produced after the seventh month.

The yearly changes in quantity is slight. The increase in

the second and third producing years is marked, but after that it is rarely more then 3 per cent. The changes are so dependent upon feeding that no conclusions can be drawn upon this point.

The percentage of the fat in milk is affected by the age of the cow. The young cow produces a milk poorer in fat than during vigorous middle age. The fat may fall to a very low per cent in old age.

There is considerable difference in the percentage of fat in the milk taken at the different parts of the milking. Schmidt made complete analyses of first drawn milk and last drawn milk, and found that this difference was almost wholly due to the fat, there being eight times more fat in the end milk than in the fore milk. We have made many tests of the fat and found the per cent. to be about five times as great in the end as in the fore milk. The explanation offered for this is that the fat at first lodges or adheres to the lactiferious ducts, and that in reality a separation of cream begins in the udder, and this fat would as far as circumstances permitted, seek to float on the denser fluid in the cisterns and teats. The udder of a cow killed immediately after milking showed on examination, that the ducts contained a residue of rich milk and it is probable that the whole of the fat is never drawn at each milking.

There has been a large number of theories advanced as to the methods by which milk is elaborated, most of them based upon the assumption that it is a comparatively simple chemical and physical problem. All the earlier theories were based upon such assumption, the physiologist regarding the mammary gland as an organ to separate certain elements from the blood in definite proportions as milk. It was regarded that the process was largely one of transudation through a special membrane, on the same principle that exchange of gases by osmosis occurs rapidly in the tissues of the lungs. It was assumed that the fat of the food, and the water and the salts taken into the alimentary canal were absorbed and taken into the blood and then eliminated by the mammary gland. The milk serum was regarded as escaped blood serum, and that the other products were derived from the blood or epithelial cells. The gland was assumed to be a semi-passive organ, receiving the milk already prepared, and only requiring elimination in the proper proportions.

It was upon the foregoing assumption, that the great majority of experiments have been made for the purpose of augmenting the quantity or quality of the milk. If this assumption

were correct, then the quantity or quality of milk produced would only be limited by the ability to digest and assimilate food.

Probably the most satisfactorally planned and executed experiments to settle this theory was made by Jordan and Jenter.* The object was to determine whether the fat in the milk was derived from the fat in the food. During the entire experiment of fifty-nine days, analyses were taken of the feeds and milk and the urine and faeces collected to determine where everything had gone. For two weeks the cow (a grade Jersey) was fed on ten pounds of timothy hay, six pounds of corn meal, five pounds of ground oats and one pound of wheat gluten. Then the same foods were fed with all or very nearly all the fat extracted. For a short time after the change there was a decided variation in the milk solids, but this was soon overcome, and the milk regained its normal composition and maintained it with only slight variations, that could not be assigned to any cause, throughout the entire period. The milk fat yield for the seventy-five days was 62.9 pounds and the food fat contained 11.6 pounds, of which only 5.7 pounds were digested. This extra fat could not have come from the previously stored body fat, because at the beginning of the experiment the cow was thin in flesh and gained forty-seven pounds body weight, and was judged to be a fatter cow at the end than at the beginning. The milk fat could not have come from the protein, because during the fifty-nine consecutive days, 38.8 pounds of milk fat was secreted and the urine nitrogen was equal about to 33 pounds of protein. According to any accepted method of interpretation, not over 17 pounds of fat could have been produced from this amount of neutralized protein. For the greater part of the milk fat, they could draw no other conclusions than that it is formed partially at least, from the carbohydrates. Several experimenters have proven that body fat may be formed from carbohydrates, and the foregoing experiment only strengthens the analogy between milk and body fat in this mode of formation. This experiment completely disproves the transudation theory, as the conditions under which it was conducted were wholly under control. It further offers an explanation for the results of many other experiments conducted along the same line, but not so completely carried out.

The transudation theory also meets a serious set back in the fact that the fats in the milk are unlike the fats in the food or

*Bulletin 132 New York State Experiment Station.

body, and that casein and milk sugar are not found in the blood or the gland itself.

Another theory that has had many supporters, is that milk is the result of the separating of part of its constituents, as the water serum and salt from the blood, and part due to a fatty degeneration of the cells lining the alveolar cavities, the fat globules being due to the degenerated cells and the casein due to the undegenerated portionof the cells. This theory is actively supported by many of the best physiologists. Smith, after examining all the phases of milk secretion, sum up the whole as follows: "The process of milk secretion may therefore be regarded as a process of metabolism of the epithelial cells, which undergo decomposition, and discharge the resulting products into the excretory ducts." He regards "fat as a product of fatty degeneration of the protoplasmic cell contents, for it is not increased but actually diminished by an increase of fat in the foods. On the other hand an increase of proteids in the diet will cause an increase in milk fat. In microscopic examination of the epithelial cells of the mammary gland, oil globules may be actually seen to increase in size and number, until often the protoplasmic content becomes almost entirely replaced by oil globules which entirely agree in their characteristics with the oil globules found in milk." In feeding animals on a highly albuminous diet, they increase in weight and produce more fat in the milk at the same time, showing that they cannot be filling the pail from adipose tissue. However, in herbivora not enough albuminoids are being taken up to account for this fact, so that some must be derived from the blood

P. Collier made an investigation* to determine the number of fat globules found in milk in a given time. He made his observations on a large number of cows and found on an average each secreted seven-tenths of a pound or nearly 19.6 cubic inches of milk per hour, and that there were 152 fat globules in each .0001 cubic inch of milk. He concluded that this was equivalent to secreting 136,000,000 fat globules per second. He duplicated his work on twenty-three other cows, and found they secreted on an average of 138,200,000 fat globules per second. Collier also recognized the fact that milk contains ingredients that must be the result of some special activity, as the casein and milk sugar are not present in the blood, and the fat only in traces, thus precluding the possibility of being derived by transu-

*New York State Experimental Station, Rept. 1891.

dation. A good cow may produce two and a half kilograms of albumenoids, fat and sugar. (five pounds) The weight of the total solids of a gland producing that amount of milk solids is only about 1.16 kilograms (two and one-fourth pounds) which would necessitate a complete renewal of tissue 2.09 times daily. He might have added that the epithelial cells constitute only a small part of the gland structure, and it would therefore require even more rapid renewal. This would require an almost incredible cell growth, so that we are forced to assume that although the growth and disappearance of certain cells is of the greatest importance, the organic substances in milk are modified from substances in the blood and lymph into the forms we find them in milk, by the functional activity of the cells. The estimates upon the rate of cell multiplication as made by Dr. Collier, are only approximate, but are certainly near enough to the truth to warrant drawing the conclusion that fat is not the result of fatty degeneration of the cells. In fact such a process is incompatible with our knowledge of the physiology of cell reproduction or disintegration.

Soxhlet has recently advanced the theory* that milk is the result of the disorganization of tissues, either as according to Volt, of the milk glands themselves or according to Rauber, of the white blood corpuscle. Thus according to Soxhlet the constituents of food cannot be directly converted into components of milk, but must first be used for the construction of some tissue and afterwards be decomposed and then be utilized in the production of milk fat. A normal butter fat could then be produced by food devoid of fat, and feeding any kind of food devoid of fat although rich in fat forming constituents, would not have the effect of changing the character of the milk fat present in milk. Abundant feeding with nutritive but non-fatty foods, could only increase the percentage of decomposing milk tissue. Carbohydrates could contribute to the body fat, but not to the milk fat, because they contribute nothing to the milk producing tissues, but on the contrary, when fed in conjunction with food poor in protein, they diminish the milk fat because the total diminishes the amount of nitrogenous food, that is, substances which produce tissue. It is only fat in food which renders the exclusive increase of milk fat possible, by causing a migration of body fat to the milk.

A close examination of the theory, and the explanation

*Journal Royal Agricultural Society, 3d Ser. Vol. III, pp. 655-662.

given by Soxhlet, shows that it explains many phenomena that could not be explained by the transudation or cell disintegration theories. It must be admitted, however, that it ignores any special constructive power in the gland itself, and treats milk as an excretory product.

The latest theory is to regard milk as a product of metabolism of the cells of the mammary gland. It is in all essential characters a secretory product, and not an excretory product. In viewing the physiology of the formation of milk in such a light, it is only regarding it in the same way as saliva, gastric and pancreatic juices. It may be argued that these glands secrete a special product to be used in the animal economy, while milk is not so used. All excretory glands, as the kidneys, liver and sweat glands, find their material already prepared in the blood, the result of activity in other parts of the body, and they serve as a means of eliminating it. Secretory glands, as the pancreas, salivary glands, etc., do not find their active principles in the blood, but construct them within their own especial cells. The mammary gland does not find fat, casein and lactose in the blood, but constructs them within its own tissues. The recognition of the mammary gland as an organ having a special function will explain fully all the difficulties met in trying to reconcile all other theories with the facts as they are observed.

The theory of special cell metabolism is supported by the behavior of the gland, viewed from an anatomical standpoint. The cells differ when at rest and when active. When at rest the cells lining the alveoli lie flat and close to the wall. Their nuclei are small and spindleform. During a period of activity they are much enlarged, filling nearly the entire cavity, and the nuclei are prominent. The cells may be seen in all stages of reproduction, and in these particulars the gland shows the same characters as seen in the secreting glands already mentioned.

This theory is further sustained by the antecedents of the milk. When fat is taken into the intestine and assimilated, it no longer has an existence as fat, but is broken up into various combinations. Fat as deposited in the body is not the same as the fat in the food. The proportions of olein and stearin have been changed to meet the peculiarity of the animal. Where the analaytic and synthetic process take place is not known. It is now recognized that it is not necessary that the fat in the body be derived from the fat of the food, but that the carbohydrates supply the necessary materials. With these proofs of synthetic process

going on, to produce body fat, it is not unreasonable to suppose that a similar process may take place in the formation of milk.

The milk sugar or lactose is a product of metabolic activity of the protoplasm of the secreting cells of the mammary gland. This particular form of sugar occurs nowhere else in the body. It is a typical carbohydrate and is found in the milk of animals fed exclusively upon meat, thus showing that the carbohydrates of the food are wholly unnecessary. Of all the constituents the milk sugar is least affected by external conditions.

The casein of milk is thought to be formed the same as the fat, although authorities differ on this point. The evidence seems to be in favor of this theory, for at the beginning and at the end of lactation the albumen which is normally less than one seventh of the casein, is actually in excess of it, and albumin is a normal constituent of both blood and milk. Smith says, casein is developed as the expense of the albuminous cell contents since it is absent from the blood. The alkali albuminate is derived from the breaking down of the protoplasm and nuclein, which is always found as a part of the casein and is derived from the nucleus which disappears in the process of secretion. The proportion of casein in the milk is increased by greater perfection in the activity of the cells. In the formation of colostrum, the albuminoid matter is greatly in excess of that after secretion is well established, and with the decrease of albumin, there is a proportionate increase in casein. A ferment has been extracted from the mammary gland which will convert albumin into casein.

The water no doubt passes directly from the capillaries into the milk follicles, and carrying with it the mineral constituents in solution.

The functions of the mammary gland are performed involuntarily. There seems to be some connection between the mammary gland and the central nervous system, but how much control can be exercised by will, has not been determined. Locally the stimulus seems to be the empty milk duct for when the ducts become full, the secretion is partially checked, but is considerably stimulated during the process of emptying.

INFLUENCES AFFECTING MILK PRODUCTION.

Breed.—Heredity has a most marked effect upon milk production. The different breeds are the result of the selection of animals of certain types, and some have been selected to produce very rich milk, others large quantities of milk, and in others

no attention has been paid to this quality. The difference in the quality of milk due to breed, includes not only the amount of fat, the color and melting point of the fat, but also the size of the milk globules. In some breeds the globules are large, in some they are small, and in some they may be mixed, large and small. While the breed has a most marked influence there is also considerable variation of the individuals in each breed.

No figures are available, that give a good index to the amount of milk and the period of lactation in the different breeds of cattle in this country. The only animals of which we have record, are individuals mainly owned by Experiment Stations, or in breeding establishments which are of more than average in quality.

Heredity.—As a breed represents only the characters of individuals fixed by selection for successive generations, it is but natural that we should find like influences in families, but in a less marked degree. Heredity has its effect in stamping individuality both in the quantity and quality, and no stronger proof is needed than the records of the noted families of the breeds.

Age.—Age will influence the quality of milk. From two until five years there is a gradual increase in the quantity, after which time it remains about the same during the periods of activity, until the age of eleven or twelve years, and then it decreases.

Pregnancy.—This state always has the effect of decreasing the flow, first due to a tendency for the body to take on flesh for a time after conception, and in a later period the nutrition is utilized for the foetus. It is in respect to the period of lactation that individuals show the widest variation. With many, the effect of again becoming pregnant is so slight as to be scarcely noticeable, and with others it is so great as to interfere with the usefulness of the animal.

THE INFLUENCE OF FOOD UPON MILK SECRETION.

During the period when physiologists attempted to explain practically all changes upon chemical and physical bases, the teaching was that milk resulted from a separation of its constituent elements from the blood, the separation taking place in the udder. Upon this teaching the belief became fixed that the quantity and quality of the milk secretion was in a measure dependent upon the amount and kind of food the animals received.

The influence of this teaching is still potent; many elaborately planned experiments have been made by individuals and Government Experiment Stations to determine the truth or falsity of this view. The results have been very confusing, unless all the data be known. It must be admitted that a large per cent of practical dairymen believe they can take poor or average cows, and by good feed and management greatly increase the quantity and better the quality of the milk produced. The results at Experiment Stations have not been wholly in accord with this view. No doubt but that the dairyman taking a cow in poor condition, scarcely receiving sufficient food to maintain the body nutrition, and giving her good care and abundant feed, will be able to increase both the yield and quality. The Experiment Station or person who takes an animal in a good state of nutrition, and feeds highly, may still further increase the flow or maintain it, and may improve the quality for a short time but not permanently. The error too often committed by the dairyman in drawing a proper conclusion, is, first testing the milk for quantity and quality, which is below the normal for the animal because of her impoverished condition, and second, in drawing the conclusions from the temporary change occurring soon after the change in food. The experiment stations as a rule, use only well nourished cattle, and consequently do not find such marked changes, and furthermore they keep the records for a longer period of time, so that the conclusions are not biased by the incomplete data obtained from the temporary changes. Among those who believe that the quality of milk is practically a fixed character in any given individual and not subject to more than temporary variation by the feeding, are G. H. Whitcher and S.M. Babcock.* The latter sums up the matter as follows:—"My opinion is that the quality of milk so far as it is measured by the per cent of fat, depends almost entirely upon individual peculiarities of the animal, and so long as sufficient food is supplied and consumed, very little depends upon the kind of food. External conditions, which often are not apparent, seem to have a greater influence upon the richness of milk than the kind of feed. This is shown by the fact that the daily variations in the per cent of fat in the milk from the same cow, when no change has been made in the ration are often greater than occur when a radical change in the food is made." Furthermore the same ration will affect different animals differently. According to this theory, the man who en-

*Rural New Yorker, July 15, 1891.

deavors to keep up the standard of his milk by careful feeding cannot attatin that end, and has no advantage over his neighbor who uses the cheapest ration possible.

According to other writers, as Youatt* and Wing,** the food has considerable influence upon the quality, but not to the some extent as the quantity. In fact, with cows kept under favorable conditions, with an abundant supply of food, it is hardly possible to increase the proportion of fat to other solids by a change in the food. While the total solids cannot be easily affected, the character of the constituents may be influenced and this is notably so of the fat. For example, linseed meal, gluten meal and certain other foods make a soft oily fat, while cottenseed meal, the seeds of the various legumes, and wheat bran make a hard fat. The constituents, other than fat, are not so easily affected. When cows are fed on watery herbage, brewers' grains or other food containing a high percentage of water, the milk becomes poorer in solids. The explanation offered for this last condition is based on the assumption of a more watery character of the blood, due to excess in the food. A poor, watery diet impoverishes the blood and leads to the production of watery milk.

The assumption of a watery diet producing a watery milk is not fully in accord with close observation, as it has been found that the fat content is not diminished by turning cattle from dry feed to pasture. It is in line, however, with the statements so frequently accredited to health boards, to the effect that cattle fed on brewers' grains and starch refuse, have a lower fat content in the milk than those using dry feeds. My own analyses do not show sufficient difference to be able to decide from the milk test which dairy uses one kind of food and another dairy a different kind.

As this phase of the subject has received so much attention from Station workers, the following summaries of experiments may be of special interest.

COMPARISONS OF GRAINS AND BY PRODUCTS.

Corn Meal and Shorts.—An experiment was conducted by the New Hampshire Experiment Station,[1] to compare corn meal and shorts. The nutritive ratios were 1 to 6.8 and 1.6:1 respectively. A difference of .34 of a pound of milk per day was realized in favor of the corn meal.

* Complete Grazier, 1893. **Milk and its products, 1897.

1 Bulletin No. 8, New Hampshire Experiment Station. G. H. Whitcher

Corn Meal and Cottonseed Meal—The same Station[1] found that a ration with corn meal, having a nutritive ratio of 1 to 5.5 and one with cottonseed meal, 1 to 4.5, gave a gain of .44 of a pound of milk more per day per cow in favor of the cottonseed meal. Of the five cows one gained on the wide ratio, two remained the same and two gained on the narrow ratio.

Corn Meal and Gluten Meal.—Corn meal was used in a ration having a nutritive ratio of 1 to 9.2, and the gluten meal at 1 to 2.4. This resulted in a decrease in the flow of milk each time the change was made, from the narrow to the wide ratio. Gluten meal also made a softer butter than corn meal.[2]

Bran and Oats.—Have about equal values.[3] At the Wisconsin Experiment Station, two feeding experiments were carried on for the purpose of ascertaining the value of ground oats and bran for milk production. The cows were fed the same quantities by weight of bran and oats, eight pounds daily per head in the first experiment, and ten pounds daily in the second, with an addition of corn meal, hay, corn silage, and corn fodder. It was found that the cows invariably did better on the oats. The fat content on the average remained the same.

Barley and Oats and a mixture of palm nut meal, rape seed cake and sunflower seed cake, were compared in co-operative experiments in Denmark. There was no change in the chemical composition of the milk from the different rations, although the quantity of the milk increased with the heavier oil cake feeding.

Gluten Meal and Cottonseed Meal.—Gluten meal was found equal to cottonseed meal when fed in such quantities as to make the digestible matter equal.[4] At the Massachusetts Station these feeds gave practically the same results.

Gluten Meal and Other Meals—Seventy cows were used in a test to determine the comparative value of gluten meal and corn meal and bran.[5] High grade gluten meal was found to have a higher feeding value than equal weights of corn meal and bran. The milk was slightly richer, but not sufficiently so to be of practical importance. The fat was disproportionately increased to other solids.

Gluten Meal and Linseed Meal.—Gluten meal and linseed

1 Bulletin 8, New Hampshire Experiment Station. G. H. Whitcher.
2 Bulletin No. 13, New Hampshire Experiment Station. A. H. Wood and C. L. Parsons.
3 Report of the Maine Experiment Station, 1896. J. M. Bartlett.
4 Report of the Maine Experiment Station, 1896. J. M. Bartlett.
5 Bulletin 48, Vermont Experiment Station. J. L. Hills.

meal were compared in feeding tests, and showed no marked difference in the quality of the milk.[1]

Gluten and Wheat Middlings.—The nutritive ratio of the gluten feed was 1 to 7.7 and the midlings 1 to 8.4. The milk yield was in favor of the gluten feed. Only one cow was used in the experiment, and thus it becomes of very little value.[2]

Gluten and Shorts.—The ratio of the gluten feed was 1 to 7.2, and of the shorts feed, 1 to 7.6, with slight advantage in favor of the gluten. Here again, only one cow was used. This was in connectiôn with the previous experiment.

Cottonseed Meal.—Butter is not appreciably affected by cottonseed meal, unless that feed be made one half or more of the grain ration.[3] Cottonseed meal also made a butter which was very hard and difficult to churn.[4]

Cottonseed and Bran.—Cottonseed had the effect of increasing the quantity of milk, but not the quality, when displacing bran in a diet. With the cottonseed diet, the melting point of the butter was 99 degrèes, and with the bran 93 degrees. This experminent was conducted upon 12 cows for 10 weeks.[5]

Cottonseed and Grains.—Cottonseed had the effect of increasing the melting point from 95.33 degrees on a straight grain and hay diet, to 105.44 degrees on a diet of cottonseed meal and beets, and decreasing the volatile acids from 14.41 parts to 10.15 parts in the fats. The quality of the milk was improved so that 21 pounds of milk produced a pound of butter against 22 and 23 pounds without the cottonseed meal. The color was also made whiter.[6]

Cottonseed.—Steamed cottonseed gave better results than raw, and the cost was one-half less than cottonseed meal. Butter from the steamed seed feeding was better than that from the raw seed feeding.[7]

Sugar Meal, Corn and Cob Meal.—Sugar meal produced 8 per cent greater yield of milk than corn and cob meal. Sugar meal produced 27 per cent greater yield of butter fat. It also produced 14 per cent greater yield of milk solids and 9 per cent more solids not fat. Sugar meal produced .58 pounds of fat, an

1 Report of the Mass. Experiment Station, 1891.
2 Bulletin 8. New Hampshire Experiment Station. G. H. Whitcher.
3 Bulletin 32. Iowa Experiment Station. C. F. Curtiss.
4 Bulletin 13. New Hampshire Experiment Station.
5 Bulletin 17. Penn., Agr. Experiment Station, Thomas F. Hunt.
6 Bulletin 18. Texas Experiment Station. George W. Curtis. Bulletin 29. corroborates the thermal test.
7 Bulletin 13. Mississippi Experiment Station. E. R. Lloyd.

equivalent of 17 per cent more than corn meal. Sugar meal also produced .73 pound or 6 per cent increase in total solids per hundred pounds over corn meal. Eight cows were used in a 60 day experiment to determine these points.[1]

Oils—Cottonseed oil, corn oil, palm oil, cocoanut oil, oleo oil, stearin oil. These were fed to three cows for the period of fifteen days—a period too short from which to be able to draw positive conclusions. The author's deductions were:—

1st.—That the first effect of an increase in fat in a cow's ration is to increase the per cent of fat in the milk.

2nd.—That with the continuance of the ration the tendency is for the milk to return to its normal condition.

3rd.—That the increase in fat is not due to the oils, but to the unnatural character of the ration.

4th.—That the results in this experiment tend to confirm the conclusion expressed in previous bulletins from this station, that the composition of cows' milk is determined by the individuality of the cow, and that although an unusual food may divert for a time the composition of the milk, its effect is not continuous.

Cottonseed Oil produced the hardest butter and corn oil the softest.[2]

Tallow.—Tallow was fed to ten different cows for a period of ten weeks, during six weeks each cow ate on an average of two pounds of tallow per day. No increase in milk fat followed.[3]

Milk.—Feeding whole milk to two cows on pasture had the effect of keeping up the flow and the per cent of fat. Skim milk did not do as well as whole milk, but showed some increase over no milk.[4]

Corn Fodder and Bean Vines.—G. H. Whitcher found that by the feeding of a herd, six pounds of corn fodder to each daily, that he received 217.54 pounds of milk, or an increase of 5.54 pounds daily over the same period during which five pounds of bean vines were being fed. He also substituted six pounds of millet for six pounds of corn fodder, and found an increase of .35 of a pound, an amount so small that it does not mean anything one way or the other.

Corn Fodder and Corn Silage have the same value.[5] At the

1 Bulletin 14, Iowa Experiment Station.
2 Bulletin 18, New Hampshire Experiment Station. A. H. Wood.
2 Bulletin 92. Cornell University Experiment Station. H. H. Wing.
4 Bulletin 17. Iowa Experiment Station. James Wilson and G. E. Patrick.
5 Bulletin 105. New York Agr. Experiment Station. Van Slyke.

Missouri Station thefodder fed cattle gave milk richer in fats and in solids.[1]

Corn Stover and Hay are of equal value.[2] Corn fodder has essentially the same value as English hay.[3] Corn fodder produced slightly less milk and of a slightly poorer quality than hay.[4]

Silage from Frosted Corn gave slightly poorer results than from unfrosted corn.[5]

Silage and Hay.—The Maine Experiment Station reports upon an experiment to determine the comparative value of good hay and corn silage. The estimates were made upon the basis of the digestible matter of each. For two months corn silage partly took the place of good hay, but it had the effect of only slightly changing the quality. The percentage of fat remained the same, but there was a small increase in quality. Whitcher made a similar èxperiment using timothy grass but in this case the silage showed decided advantages.

Corn and Clover Silage.—The Vermont Experiment Station compared corn silage with clover silage, with the result that all ten of the cows gave a better quality of milk on corn than on clover silage. The butter fat was 35 per cent higher or 8 per cent better in the milk during the corn silage feeding period.

Silage.—Change from dry feed to silage resulted in slight increase in both quantity and quality.[6] Silage produced less milk than hay, the quality being the same.[7] Silage feeding favored milk and butter production, while timothy hay favored fat production.[8] Silage produces a softer butter than hay.[9] At the Maine Station silage was slightly better than hay for milk production.[10]

Soy beans were better than the vetch or oats in five out of six cases.[11]

Hungarian hay gave poorer returns than silage.[12]

Prairie hay is equal to timothy hay.[13]

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1 Bulletin 8, Missouri Agr. Experiment Station. J. W. Sanborn.
2 Report Vermont Agricultural Experiment Station, 1889. J. L. Hill.
3 Report Massachusetts Agr. Experiment Station, 1888.
4 Report Vermont Agr. Experiment Station, 1890. J. L. Hills.
5 Report Vermont Agr. Experiment Station, 1889. J. L. Hills.
6 Bulletin No. 9, New Hampshire Agr. Experiment Station. G. H. Whitcher.
7 Report Verment Experiment Station, 1890. J. L. Hills.
8 Bulletin 4, Minnesota Agr. Experiment Station. Edward D. Porter
9 Bulletin 13, New Hampshire Experiment Station. A. H. Wood and C. L. Parsons.
10 Report of Maine Agr. Experiment Station, 1889.
11 Report Maine Agr. Exp. Station. 1890,
12 Report Vermont Exp. Station, 1889. J. L. Hills.
13 Bulletin 30, Minnesota Agr. Exp. Station. T. L. Hacker.

Bermuda hay and timothy hay are equal.[1] The cows were given a preliminary ration of 1 :6 and changes made in the hay.

Clover hay caused an increase or prevented the natural decrease at each period at which it was used. A shrinkage occurred at each time the change occurred away from the clover.

Vetch hay caused a slight gain.

Mixed hay gave an increase over mixed and oat hay.

Oat hay had less value than other fodder. The effects was upon quantity and not quality.[2]

Peas and oat hay were not relished but when eaten gave high value.[3]

Apple pomace has about the same value as silage.[4]

Beets were found to increase the flow of milk, but not enough to pay for the extra cost of the ration.[5]

Sugar beets as well as carrots almost without exception temporarily raise the quality of milk.[6] They give butter of good color which keeps well, but like that from potatoes is not of high grade.[7]

Sugar beet pulp, pound for pound on the basis of dry matter was found to be equal to corn silage. The milk produced from feeding the beet pulp, as it comes from the sugar beet factory is worth about one-half that of corn silage. In this experiment five cows were used for a period of eleven weeks, the time being equally divided between the two feeds. There was no constant effect upon the percentage of fat.[8]

Roots were compared with silage in a feeding trial with the result that apparently the roots seemed to do best, but estimated on the basis of air dried content, the silage gave the best results.[9]

Green Food.—A change from dry to green food increased the quantity, but only slightly altered the quality.[10]

Carrots had the greater value pound for pound for the vegetable matter they contained than corn silage.[11]

1 Bulletin 21, Mississippi Agr. Exp. Station. E. B. Lloyd.
2 Bulletin 13, New Hampshire Agr. Exp. Station. G. H. Whitcher.
3 Report Vermont Agr. Exp. Station, 1899. J. L. Hills.
4 Ibid.
5 Bulletin 5, Ohio Agr. Experiment Station, Vol. III.
6 Report Massachusetts Agr. Experiment Station, 1889.
7 Bulletin 17, Iowa Agr. Experiment Station. F. A. Leighton and D. B Bisbee.
8 Bulletin 183, Cornell Agr. Experiment Station. H. H. Wing and Leroy Anderson.
9 Bulletin 26, Penn. Agr. Exp. Station. H. J. Watters and R. J. Weld.
10 Bulletin 9, New Hampshire Exp. Station. G. H. Whitcher.
11 Report Mass. Agr. Exp. Sta. 1883.

Potatoes produced a butter that is colorless and lacks keeping qualities.

Pasture with Grain Ration Added.—An experiment was conducted to try the influence of the addition of a grain ration to cows on pasture. Three cows were kept on pasture only, and three were given grain. The lot on pasture only, decreased from 20.60 pounds to 17.88 pounds of milk and .86 pounds to .77 pounds fat and the per cent of fat increased from 4.19 to 4.29 lbs. from June 8 to September 21. During the same period the grain fed lot decreased from 20.55 pounds to 13.09 pounds of milk; and .86 to .65 pounds of fat, and increased the per cent of fat from 4.18 per cent to 4.95 per cent. The final result was too close to draw a definite conclusion.[1] This work was duplicated and reported in bulletin 22, when Lot I produced a total of 118.4 pounds of butter fat and Lot II 119.72 pounds. Lot II consumed 2822 pounds of wheat bran and cottonseed meal. The experiment was again repeated and reported in Bulletin 36, at which time the grain feeding showed better because of the short pasture.

Pasture Alone. —For the production of milk there is no feed so cheap as grass.[2] Changing cattle from barn feeding to pasure resulted in more and better milk.[3]

Drouth caused a great shrinkage in milk.[4]

Miscellaneous.—The following rations (1) cottonseed, corn meal and wheat bran; (2) peas and barley; and (3) linseed meal, corn meal and wheat bran, were alternated through three periods. There was less variation because of the changes of feed than is often seen in uncommon feeding; the quantity was diminished slightly in passing from the first to the second and increased in passing from the second to the third feeding. The melting point of the butter and the percentage of olein was lower in the second than in the others.[5]

Heavy Grain.—In general it may be said that the limit to assimilate a heavy grain feed and respond in milk produce, is dependent upon the individuality of the animal.[6]

Light and Heavy Meals.—Light foods as bran, are often as good, weight for weight, as heavier for quantity and quality of

1 Bulletin 13, Cornell Uni. Agr. Ex. Sta. I. P. Roberts and H. H. Wing.
2 Bulletin 52, Cornell Univ. Agr. Exp. Sta. H. H. Wing.
3 Report Vermont Agr. Exp. Station, 1890. J. L. Hills.
4 Bulletin 105, New York Agr. Exp. Station. L. L. VanSlyke.
5 Report of Maine Agr. Exp. Station, 1891.
6 Report Vermont Agr. Exp. Station, 1890. J. L. Hills.

milk, but seems to cream less thoroughly than from heavier meals.[1]

Heavy grain had the effect of decreasing the hardness of the butter.[2]

Nutritive Ratio.—No relation was found between the nutritive values of fodders and the products formed, or between the albuminoids of the food and the casein in the milk.[3]

Changing Feeds.—The final results in changing food showed that there was little change in the total fat produced, as change in quality was compensated for by quantity.[4]

Diet.—The influence of a certain diet may have a widely indifferent effect on different animals.[5] No relation was found to exist between foods and volatile fatty acids, except in the case of skim milk.[6]

Narrow and Wide Rations.—Two rations containing approximatety the same quantity of digestible matter, one narrow and the other wide, gave from 20 to 36 per cent more milk on the narrow, and from 30 to 40 per cent higher total solids on the narrow, than on the wider rations. In the experiment three cows were used for three periods of thirty-five days each. The wide ration was 1 to 12:3; the narrow ration 1 to 6.7.[7]

Rations may have equal digestible constituents, but be derived from different sources, as follows:—

	Ration I.	Ration II.
Timothy hay	5	15
Corn silage	40	25
Oats ground	5	0
Peas ground	6	0
Malt sprouts	0	2
Brewers' grains dried	0	3
Buffalo gluten feed	0	3

Ration No. 1 is supposed to have the larger proportion of easily digestible carbohydrates, but it had no advantage over No. 2 in milk production.[8]

The effect of widening a nutritive ratio from 1:5 to 1:9 and from 1:5.6 to 1:8 was to cause a decrease of from 8 to 13 per

1 Report of Vermont Agr. Exp. Station, 1890. J. L. Hills.
2 Bulletin 13, New Hampshre Agrl. Exp. Station, 1890. G. H. Whitcher.
3 Report of Vermont Agr. Exp. Station, 1889. J. L. Hills.
4 Bulletin 30, Nebraska Agr. Station. C. L. Ingersoll and H. B. Duncanson.
5 Report of Mass. Agr. Exp. Sta., 1888.
6 Bulletin 13, New Hampshire Agr. Exp. Sta. A. H. Wood and C. L. Parsons.
7 Report of Maine Agr. Exp. Station, 1893. W. H. Jordan.
8 Bulletin 141, New York Agr. Exp. Station. W. H. Jordan and C. G. Jenter.

cent in the flow.[1] With the same cows hardness depends more upon the character of the feed than upon the nutritive ratio.[2]

While the foregoing experiments are typical of the work done to determine the effect of food upon the quantity and quality of milk, they seem to show that some foods have more effect upon milk production than others. In all cases the influence is within narrow limits, and can all probably be accounted for by the general effect upon the body, or by one food being more palatable than another and therefore more aggreeable to the animal. The effect upon milk is probably no greater that it is upon the body as a whole.

The discrepancy between the results obtained by different experimenters may often be accounted for by the difference in the method of conducting the experiments. The usual length of time given to each period in a feeding experiment is ten days or two weeks. Many foods have a temporary stimulating effect, which food naturally shows in such short period experiments, and which would disappear if the period were continued for a longer time.

The duration of the period, which should be given to an experiment, was also studied at the Vermont Experiment Station. Their results show that the period should be about four weeks, in order to make a comparison of quantity, and that the period should be six weeks or more in order to get a comparison in quality. This is another evidence of the slow rate which physiological changes take place in an organ having a fixed habit, and also the folly of drawing conclusions from short experiments upon animals.

Effects of Certain Foods and Drugs.[3] —A great many substances may be transmitted to the milk. The volatile fats that are derived directly from the food may give either desirable or undesirable flavors to the milk. The characteristic flavors we esteem are due to the grasses, clover and like fodders, while the undesirable are due to leek, garlic, onions, turnips, cabbages, fish, etc. We also find poisonous substances such as camphor, turpentine and camomile, aloes, arsenic, lead and tartaric acid transmitted to the milk. Milk to which aloes, mercury and copper have been transmitted is frequently injurious. If proper precaution is taken the undesirable flavors and detrimen-

1 Bulletin 9, New Hampshire Agr. Exp. Station. G. H. Whitcher.

2 Bulletin 13, New Hampshire Agr. Exp. Station. A. H. Wood and C. L. Parsons.

3 Experiment Station Record, Vol. V., p. 973.

tal effects may be easily obviated, since all these flavoring oils pass off through the excretory channels in a comparatively short time. We shall find them present in the greatest amount, not only in the milk but in all the tissues of the animal during the time the fodder containing them in undergoing digestion, and by the time digestion is completed, the volatile products will have almost entirely passed away. Thus, if care is taken in feeding so that it will be performed at least eight to ten hours before milking, there will be slight danger of contaminating it. If milking should occur in four or five hours, the milk will have an undesirable flavor. Taking advantage of this, and feeding the cow immediately before or after, dairymen are often enabled to feed large quantities of turnips, and even onions without contamination of the milk. The presence of wild garlic and wild onions in the pasture, is a source of bad flavor to the milk. Of course the remedy here is to remove the wild garlic and onions. It is claimed that placing a small piece of salt petre in the milking pail will counteract the odor of the turnips. A peck of onions fed to a cow will impart no more odor to the milk than will a small piece of onion added to the milk. Vandenhoydouch[1] reports a case in which the milk of all the cows of a village became bitter, although the cows were healthy. The cows were fed on Swedish turnips which had been washed in foul ditch water. As soon as this was discovered and remedied the milk became all right. Weigmann and Zurn report a case in which the straw used for bedding caused soapy milk. E. Hess, J. Schaffer and H. Lang have observed the effects of glaubers salts[2] on some of the cattle of Switzerland. They fed four cows, increasing from 40 to 60 grains per head daily, and compared the results with common salt. The cows gave signs of disease of the udder, such as bloody milk, caking and catarrh. After four days the milk was again normal, but had a taste similar to a weak solution of glaubers salts. The most striking change in the milk was a decrease in the ability of the casein to be curdled in rennet. The effect of feeding potassium chlorate according to Bieler, was an increase in the yield of milk at the expense of quality. Cornevin found that pilocarpin increased the sugar from about 65 per cent of a gram to 5.5 grams per litre.

Soxhet[3] has succeeded in demonstrating that butter made

1 Experiment Station Record, Vol. V., p. 971.
2 Experiment Station Record, Vol. V., p. 971.
3 Journal Royal Agricultural Society, Third series, Vol. III, 655-662.

from cows fed oil has a melting point of 10 degrees F. higher than normal butter.

Effect of Water.—There is a popular notion that the more water that a cow can be induced to take into the system, the more milk she will yield. To prove this, animals were fed silage two periods, with corn fodder between and succeeding which corn fodder with silage was used. In every case where there had been a decrease in milk flow there had been a decrease in total amount of water taken into the system and in every case where there had been a gain in the milk, there had been an increase in the amount of water taken into the system. Three cows drank for both silage periods 2182 pounds water, and both fodder periods 2849 pounds of water, but the silage eaten contained 2489 pounds of water, so that the total water taken during the silage period was 6226 pounds, while for the fodder period only 5435 pounds of water. For the silage periods the cows gave 19.07 pounds of milk, and the fodder periods 18.51 pounds of milk, showing that during the period in which the greatest quantity of water was taken into the system they gave the most milk in return. It is also shown that as the period of lactation advances the amount of decrease of water taken into the system and the amountof milk produced are almost exactly in the same proportion, that is, the decrease of water taken in during the second silage period was 19 per cent of the amount in the first, while the milk decreased 20 per cent.

In the fodder period, the second shows a decrease of 14 per cent of water and 13 per cent of milk over the first period, while in all the periods the decrease of 14 per cent of water and 13 per cent of milk occurred from the first.

That this is not chance, but characteristic of cows, will appear from a study of the experiment made during three years at the Wisconsin Experiment Station* and in seven out of eight tests the cows took more water into the system daily and gave more milk while eating silage than on corn fodder, and in the other cases the amounts were equal, thus showing that the rations which produced the most milk contained the most water. When silage was fed with water at 39 degrees F. there were 2.9 pounds of water drank for each pound of milk yielded.

Minnesota conducted a like experiment giving three cows water at 70 degrees, and three cows water at 33 degrees. The three cows receiving the warm water drank an average of 95

*Wisconsin Agricultural Experiment Station. Bull. 21, and Repts. '89,-'90.

pounds daily; those receiving the cold water drank 87 pounds daily. No special difference could be attributed to the one over the other, either on the milk or butter. The animals receiving the warm water gained 43 pounds, while those receiving the cold water gained 140 pounds.[1] A similar experiment conducted in Michigan[2] from January 19 to March 14, using water at the freezing point and at 60 degrees, showed that on four cows there was a gain of only 45½ pounds of milk during the entire period. It is also recorded by the Vermont Experiment Station that water at 40 degrees was taken as freely as the above.[3]

There is supposed to be a difference in the comparative value of warm and cold water for milk cows. To prove this, two experiments were conducted at the Wisconsin Experiment Station to ascertain the effect of the temperature of the water on the milk production. One experiment lasted for sixty-four days and the other one for sixty days. There were six cows used in each test. One lot was given water at a temperature of 32 degrees F. and the other 70 degrees F. In the first experiment the time was divided into three periods of sixteen days each with intervals between them. At the close of these periods the water temperatures were reversed, that is, the cows which received water at 32 degrees F. were given water at 70 degrees F. and vice versa. The warm water gave the best results, making 1.002 pounds of milk more per day. The cows ate more while on warm water than on the cold. The fat content was about the same in the samples of the different milk.

It is an interesting fact that a cow in full flow of milk requires from one-fourth to one-third more water, than when she is not giving milk, and a cow giving a large quantity of milk requires more than one not giving so much. Cows not giving milk require from 70 to 80 pounds daily upon dry feed and from 100 to 120 pounds daily when giving milk.

The Effect of Change in Temperature and Storms.—The effect of sudden change in temperature seems to affect the secretion of milk in an indirect manner through the nervous system. It would be but natural to expect that some effect would be noticed either upon the quantity or quality of both. An examination of the milk in butter fat record of the cow Early Morn at the Indiana Station for one year, fails to show any connection between the quantity or quality of her milk, and the condition of

1 Bulletin No. 4, Minnesota Agr. Exp. Station. Edward D. Porter.

2 Michigan Agr. Exp. Station Bull. 41.

3 Report Vermont Agr. Exp. Station, 1889. J. L. Hills.

the weather. In fact her greatest variations occurred at times when the weather was stationary. It may be remarked in this case, that this might be due in part to the unusual good protection which she received.

The study made upon the effect of temperature at the Vermont Experiment Station and its results seems to show that the effect of temperature upon the quality of milk is an inverse one, that almost two-thirds or exactly 61 per cent. of the changes in quality were in opposite directions to the changes in temperature. During the period under observation there were thirty-one changes of temperature, seventeen rising, ten falling, four stationary. On fifteen of the days, when the weather became warmer the fat in the milk decreased, and as the weather became cooler, the fat increased. The tendency from this would seem to be that the milk became richer when the temperature was falling, and less rich during the rising temperature. In the test in 1892 there were 55 chances for comparing the effect of changing temperature upon the per cent of total of fat in milk, and 33 to test the effect on the per cent of total solids. There were 22 cases of rising, 21 of falling and 12 of stationary noon temperature. During the twenty-one days the fat percentage in night's milk changed in opposite direction to the temperature, during eighteen it changed in the same direction, and in four cases there was no change in fat per cent, thus confirming the former test. The total solids were found to rise and fall in much the same way as the fat. During the thirty-three days of the first half of the test, in which the calculations of the solids were made, there were fourteen days of raising, twelve of falling and seven of stationary noon temperature. On fifteen days the totai solids percentage in the night milk varied inversely, on seven days the changes were in the same direction and there were four cases of no change. A little more than two-thirds (68 per cent) of the changes were in the opposite direction to the temperature changes. In the experiments, the changes in the inverse direction were more decided than those in the same direction.

During the test made in 1891 by the Vermont Experiment Station*, there were several heavy storms. The amount of milk delivered immediately following these was larger than just before. The quality of milk cannot be said to vary much in any direction, but the milk of the second morning after the storm was less in quantity and richer in quality than before. The

*Rept. Vermont Agr. Exp. Station, 1891.

amount of this disturbance was not in accord with the size of the storm. The cows do not appear to have made any change in the quantity or quality of the milk on the approach of the storm, and no connection is traceable between the storms and pounds of butter produced. Observations after sixty storms show that after seven there was diminished quantity and after three there was no change.*

In experiments conducted at this Station (Indiana) in 1893 milch cows exposed to the weather in the winter, but provided with night shelter made a very unfavorable showing, as compared with those given shelter in the stable excepting for brief airing when the weather was suitable. The exposed cows ate more food, lost in weight and also in milk yield, while the sheltered ones gained in weight and made a better showing. At the Kansas Experiment Station similar results were obtained.

Regularity and Uniformity of Milking.—While the process of milk secretion is a continuous one, it is not entirely uniform, for, as is generally believed, the rate of secretion is increased greatly while milking. Again, in proof of this the distention of the milk ducts and reservoirs by milk already present, acts as a check upon secretion. In all cases the udder becomes unduly distended with milk between milkings, and an increased flow will be secured by milking off the milk. The time of milking should be regular, for a difference of an hour will frequently make a difference of 10 per cent in the amount secreted, and if the irregularities are frequent a diminished flow will result. The amount given is also considerably affected by the way in which the milk is drawn. In general it may be said that rapid milking is conducive to a large flow. At all times the milk should be drawn so that no discomfort is caused to the animal and in this respect there is a great difference among milkers. A rapid, uniform stroke with a firm touch of the teat and a stroking motion of the lower part of the udder gives the best results. Babcock has found that certain milkers get not only more but richer milk than others from the same cow.

The Vermont Experiment Station undertook to demonstrate**the fact that fast milking is more advantageous than slow. In so doing, eight cows were used in an experiment—Four full milkers and four strippers. The slow milking took from two to two and one-half times as long as the rapid milking. The ex-

*Bulletin 30, Nebraska Agr. Exp. Station. C. L. Ingersoll and H. B. Duncanson.

**Vermont Experiment Station. Report, '91, p. 55.

periment proved two things: 1st.—The diminution in the milk flow from one period to another, 2nd.—Essentially unchanged quality. All the cows gave less when milked slowly, although in three cases the difference was but slight. The same station demonstrated that the quality is lowered but quantity increased by milking them three times a day.

Two cows milked every hour for seventy-two hours gained both in quantity and per cent of fat. The gain the first day was much greater than on the subsequent day.[1]

[2]H. H. Dean tried milking diagonal teats to see if there would be an increase in the milk production. With one cow there was no difference, with another, less milk was given. F. Albert tried a similar experiment and found that by milking the quarters or diagonal teats that there was a marked increase in the quantity. He was so sure of his conclusions that he strongly recommends that this method of milking be always followed.

Dr. E. L. Sturtevant had the different quarters of the udder of a cow milked separately a number of times, and the milk weighed, and the total solids and fat determined. He found a marked difference in the quality of the milk from different quarters of the udder. Dr. Babcock made a similar experiment along the same lines and his results may be briefly stated that, for any single milking the results fully confirmed those of Dr. Sturtevant, and showed a decided difference in the quality of the milk from different teats: If, however, the whole series be considered it is evident that the order in which the teats are milked is the chief factor which affects the quality of the milk. Dr. Babcock says in conclusion, "It is doubtful about there being any difference in the physiological function of the different quarters of the udder." At the Indiana Experiment Station like experiments were conducted with the same results. At the North Carolina Station cows milked one teat at a time showed a less per cent of fat than those milked as usual.[3]

Effect of Exercise.—Though locomotion is detrimental to the yield of milk, it is a mistake to suppose that uninterrupted confinement in the stall is the most economical treatment for a milk cow. With moderate locomotive exercise, the slight reduction in quantity of milk appears to be fully compensated by the increased yield of solids. Munk undertook to settle this

1 Bulletin 9, New Hampshire Agr. Exp. Station. G. H. Whitcher.
2 Experiment Station Record, Vol. V. pp. 965.
3 Bulletin 116, North Carolina Agr. Exp. Sta. F. E. Emery.

point, and experimented with thirty cows and found that when they were allowed half an hour daily exercise the total quantity of the milk as well as the fat and casein increased, though much exercise exerted an adverse influence on the yield. When cows are on grass their increased appetites in the presence of an abundance of food quite makes up for any loss incurred in the movement necessary to obtain that food. Hence it is desirable that stall fed milk cows should have daily exercise. Very violent exercise sometimes has the effect of producing very much change in the quality as well as the quantity. It always has the effect of lessening the quantity but the effect upon chemical composition is not known. There are numerous instances, however, in which the physiological effect of taking milk from an exhausted animal has proved injurious. It is generally recognized among farmers that it is unsafe to allow a calf or colt to suckle when the dam is overheated. Two observations upon this point are recorded as follows:—

On April 30, 1898, at Lake City, Fla., a fine cow was owned by Mr. P. She had a calf some five miles from home and the calf was a week old, strong and healthy. The calf was hauled home in a buggy and the cow made to walk. She ran a considerable of the distance and was exhausted when the barn was reached. The calf suckled on arrival home and soon became very sick with a violent diarrhoeal discharge.

In 1895 the cows owned by some people in West LaFayette, were herded by a boy. He drove them home very hurriedly one night to avoid a rain storm. They were somewhat overheated and gave a small quantity of milk that night. Two calves became attacked with diarrhoea. Several people were also affected. In two cases mammitis, was the result of the bruising of the udder in running.

Effect of Change of Location.—The effect of a change of quarters on the quantity and quality of milk was experimented upon by the Vermont Station. The herd was milked and then driven three and one-half miles to new quarters. Composite samples were taken of the milk of seven cows for four milkings before and after the change. There were six and one per cent larger yields of milk ingredients followed the change. Babcock found in a similar experiment a falling off in both quantity and quality, but the increase of the succeeding days more than compensated for the decrease. A change in the stable routine, as

feeding out of order or at irregular times may have like effect*.

Effect of Nervousness.—Both the secretion and the excretion of the milk are under the control of the nervous system, but the exact mode whereby the nervous influence is exerted, remains to be worked out. Indirectly, however, the secretion of milk must be largely affected through the sympathetic nervous system, whose center is a chain of nervous element extending along the general body cavity just beneath the back bone. The nerves act, by controlling the caliber of the blood vessels, and thus regulating the blood going to the udder. It is a well established fact that anxiety of the mother, caused by removal of the young, as well as by sudden fear, all chance excitement of any kind, will cause a partial and sometimes a complete suppression of the milk secretion. Not only is the amount of milk secreted affected by the nervous state of the animal, but its composition is also changed even when the quantity remains the same. Unkind treatment of the cow, willful or otherwise, is found to show its effect in diminishing the yields of milk. Ill ventilated, badly drained or too draughty cow houses, careless exposure in bad weather, irregular feeding, brutal usage, fast driving, the mad rushing about, provoked by the attacks of ox warble fly and a variety of other causes, are bound to exert an influence upon the nerves, the effect of which will be certainly recorded in the milk pail. At the Vermont Station a test was made of dairy cows at home and at the fair ground,** to determine the effect of the nervous excitement on the milk flow. The results indicate that the tendency of nervous excitement is to lessen the quantity of milk and to variously affect the quality, according to the individuality of the animal, the fat being the most variable ingredient. In general, the activity of the animal and the nervous excitement decreases the flow of milk, stall fed animals producing more than grazing animals.

The Effect of Rage, Fright and Sudden Shocks all have a marked effect upon the quantity and probably upon the quality. Flint reports Vermois and Becquerel as mentioning a very striking case, in which a wet nurse in a hospital lost her child from pneumonia and was deeply affected and grieved. She immediately had a marked dimunition in the quantity of her milk and a dimunition in the proportion of salts, sugar, and butter. There was an increase in the casein. The same writer quotes Sir Ashley

*Bulletin 116, North Carolina Exp. Sta. F. E. Emery.
**Vermont Experiment Sta. Report 1895.

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Cooper as mentioning two cases in which the secretion was instantly and permanently arrested by terror. There are a large number of such reports due to mental impressions.

Similar observations have been made upon animals. On August 12, 1892, at Lake City, Fla., the following case occurred: A fine cow owned by Mrs. T. had a healthy calf four days old at her side. The cow was of a very nervous temperament, and particularly adverse to dogs. Upon the night of that date, the dog strayed into the stall next to the cow and calf. The cow made frantic efforts to get at the dog, and was in a state of excitement for six hours. The calf remained quiet and unharmed. Three hours after the calf suckled, it died.

Another case occurred August 10, 1891, at Bourbon, Ind. A valuable mare was owned by Mr. C. She had a foal six weeks old. The day was very hot and the mare was used at the harrow, and the colt left in the shade. The mare fretted greatly and was worked a couple of hours longer than usual to finish a piece of work. The foal was allowed to suckle as soon as work was stopped. It died in about four hours. No cause could be assigned, except the possibility of the milk having become altered both by fretting and work.

It has also been observed that after sheep have been frightened or worried by dogs, a number of lambs may die which have in no way been disturbed or injured by the dogs. It seems in such cases as though the milk had induced the trouble.

Effect of Abortion —The Vermont Experiment* Station has made several observations on the effect of abortion, on the quantity and quality of milk, the most important of which are as follows:—That there is a shrinkage of over one-third of milk yield, a gain of one-tenth in quality, shrinkage of nearly one-third in butter yield and a more even quality of milk throughout the year was obtained. In seven cases out of eight the quality of the milk both as regards fat and solids not fat, was better than that given after normal calving.

The herd at the Minnesota Experiment Station has likewise been troubled with abortion. In the following table are the records of five cows for six months immediately following normal calving, which preceeded abortion and for six months following abortion.

*Vermont Experiment Station, Report, 1892.

TABLE XXVI.
Influence of Abortion on Quantity and Quality of Milk.

	Normal Calving			Abortion		
Name of cow	Pounds milk	Per cent. fat	Pounds fat	Pounds milk	Per cent. fat	Pounds fat
Beckley	2.891	5.89	170.3	2032	5.84	118.6
Clara	3.437	4.40	151.2	2937	4.63	135.9
Rosey	37.84	5.40	142.7	3765	5.79	153.9
Lorry	4.181	4.54	189.6	2736	4.76	130.0
Sulley	3324	4.41	146.3	3737	4.68	174.9

Three gave less milk and butter after abortion than after normal calving, two gave more, four gave better milk and one milk of the same quality. The differences on the whole, were less pronounced than in the Vermont herd.

Effect of Sickness.—A general disease may have an immediate effect upon the quantity and quality of milk. The usual result is to make a diminution of the quantity, and frequently it does not return to normal after the animal has gotten well. The effects of an over feed is shown in the following table:

TABLE XXVII.

Date	Pounds milk, a. m.	Per cent. fat	Pounds milk, a. m.	Per cent fat
3—11	16.3	4.8	10.8	7.5
12	3.8	4.2	6.8	9.5
13	2.2	18.	1.7	14.
14	3.8	14.	5.2	2.9
15	6.2	8.	4.5	8.4
16	7.8	6.8	7.	5.8
17	10.	4.4	8.5	4.4
18.	11.	4.4	8.1	4.8
19 .	12.6	4.4	9.8	6.
20	13.7	4.5	10.6	5.4

Effect of Tuberculin.—The effect of tuberculin has been noted by a number of writers, and has been made the subject of special experimental research at three different experiment stations. The result of all the work is to show that tuberculin probably has no effect upon the quantity or quality of the milk. That equal or greater changes, may take place at any time without the injection of tuberculin. In some cows the quantity of milk is slightly increased, and in others it is decreased. The principle experiments to determine the effect of the tubeculin injection have been conducted at the New York and North Dakota experiment stations.

Effects of Dehorning.—The effects of a surgical operation such as dehorning, upon the milk flow, is of only a temporary character. The effect of dehorning has been observed at several of the experiment stations, and the effect has usually been of temporary shrinkage in the milk, lasting only a few days. At Minnesota the cows were divided into two lots, part dehorned and part left to witness the act. Those dehorned had a shrinkage of seven per cent in quantity of milk and three per cent in fat. Those witnessing the work and smelling the blood lost three per cent in quantity and eleven per cent in fat.* In Georgia only twenty pounds of milk were lost, the first day after dehorning eight cows.

Effects of Spaying.—The immediate effect of spaying is to cause a shrinkage in the milk flow. This is usually recovered in two or three days. The prominent effect is to prolong the period of lactation for two or three years. It neither increases the daily yield or improves the quality.

*Bull 19, Minn. Ex. Sta. Clinton D. Smith and T. L. Hacker.

THE SUGAR BEET IN INDIANA.

Summary of Sugar Beet Tests in Indiana, 1888 to 1900.

By H. A. Huston.

During the past thirteen years the Station has annually raised experimental crops of sugar beets on the Station farm, and during eight years of this period a considerable number of farmers and of organizations of various kinds have also raised beets from seed distributed by the Station. In the years 1891 to 1894 we received samples of beets from an average of thirty-eight stations in twenty-three counties. In 1895 and 1896 no seed was distributed by the Station. In 1897 there was a marked increase in the popular interest taken in the subject and 143 stations representing thirty-five counties sent samples. In 1898 the interest increased, and we furnished seed to 1,160 persons and received samples from 285 persons representing fifty-seven counties. The results of the work up to the close of 1898 have been published in detail in the Station bulletins.

In 1899 seed was distributed to 352 persons in seventy-nine counties, and 269 samples were received from sixty-nine stations, representing thirty-eight counties. In 1900 seed was distributed to 127 persons in sixty-one counties, and 116 samples were received from fifty-nine stations representing twenty-three counties.

In 1901 no seed was distributed and only a very few applications for it were received. During the last ten years samples have been received from eighty-four counties in the State. From some counties a considerable number of samples have been received for a period covering several years and the results may be considered as fairly indicating whether the crop is a suitable one for the county. In other cases only a few samples have been received from certain counties and unless these results are considered in connection with the location and general agricultural conditions of the county, there is danger of concluding that some counties are unsuited to raising beets and that others are well adapted to beet raising, when the real facts are that not enough persons have raised beets in these counties to permit a correct conclusion to be based on the results of the analyses alone.

CONDITIONS NECESSARY FOR THE SUCCESS OF A SUGAR BEET FACTORY.

The first condition is a supply of beets satisfactory in amount and quality. To secure this requires a willingness on the part of farmers to engage regularly in the production of the crop, since few factories care to own and manage land enough to provide the factories with beets, soil of such character as to permit the economic production of the beets, and climatic conditions suited to the production of beets of proper sugar content and purity.

The second condition is a satisfactory situation in reference to obtaining fuel, water, and lime rock.

The third condition is a factory of first rate construction and arrangement, large capacity and under competent management.

The fourth condition is to locate the factory where there are good transportation facilities for bringing in supplies of fuel and beets and for taking the sugar to market.

The last condition is a market for the sugar and side products of the factory.

The history of the development of the sugar beet industry in America shows that for many years the attempt to establish factories were failures and these failures were mainly due to the fact that the first and third conditions named above were not complied with.

DO THE NECESSARY CONDITIONS EXIST IN INDIANA?

In northern and in a part of central Indiana all the conditions are found for the successful establishment of the industry. In several of the northern counties the farmers have already entered into contracts and have raised beets for factory purposes. While in some cases the farmers have not done as well with the first crop as they had hoped to do, it should be kept in mind that the work was new to them and their first experience is not different from that in states where the industry is now well established and where farmers find beet contracts very profitable. The Indiana farmers made contracts expecting to deliver direct to local factories, but for various causes these factories were not built and the beets were shipped by rail to factories in other States. Even under these conditions farmers are still willing to engage in the beet raising, as is shown by the considerable acreage

planted this year. With factories located in the State, there is little doubt that the acreage could readily be increased to a point which would give a good supply of beets for factory purposes. For several years we have asked all who have sent us samples whether they considered the crop profitable at present prices, and in practically every case where the beets were raised on suitable soil, the farmers have stated that they believed the crop to be a profitable one, and many have expressed a willingness to enter into contracts to produce them for factories. If factories were established in the northern counties of the State, there would be little difficulty in inducing farmers to contract to furnish an adequate supply of beets.

SOIL CONDITIONS.

So far as soil conditions are concerned there are great areas of comparatively new and fertile light lands in the northern section of the State, that are most admirably adapted to beet culture. The land is very easily worked and produces beets of fine form and quality. The lightness of the soil makes the labor of cultivation and thinning much less than in Nebraska, and the fact that the permanent water level is only a few feet below the surface, reduces the danger from drouth. Much of this land is too light for wheat land, and is to be classed as truck land. Alternating with the light lands are strips of muck lands that are of high value for keeping up the supply of nitrogen and organic matter on the lighter lands. In the territory drained by the Kankakee, Tippecanoe and St. Mary's rivers, there are very large bodies of these light lands that are not of high value for general farming but that are extremely well adapted to beet culture. Further south there are great areas of black prairie land that are also well suited to the purpose. But it is not likely that these lands will be used for beet raising for some time, since those which have been under cultivation for some time are now fine corn and wheat lands, and their owners prefer to raise large areas of corn, wheat and oats, and to handle considerable quantities of cattle and hogs.

CLIMATIC CONDITIONS.

During the time that efforts were being made to establish the beet industry in America, it was believed that the temperature of the three summer months was a controlling factor in beet

production and a belt 200 miles wide was laid off through the center of which passed a line along which the average temperature of the three summer months was 70 degrees F. The lower side of this belt in Indiana passes through the southern parts of Vermillion, Hamilton and Union counties, so that fully one-half of the State is within this belt. It is not to be understood that all land within the 200-mile strip is suitable for beet raising, or that it is impossible to raise satisfactory beets outside of this area. Some successful beet factories are already located outside this belt in other States. Other conditions enter into the matter, and one of the most important is the temperature and rainfall of the three autumn months. A warm, moist autumn permits of a continuous growth of the beets, or starts a second growth, and under these conditions the sugar content of the beets is much lower than is found in normally matured beets. The conditions in northern Indiana favor a proper ripening of the beets in the latter part of September in an average year. In some of the northern counties we have conducted special work on this point, and the results show that factories may start in September and have a good supply of high grade beets. The factories could run well toward the end of December, as the temperatures of this month are seldom low enough to require harvesting beets. The following table gives the mean temperature and precipitation for each month for a period of seventeen years.

In the various bulletins relating to sugar beets will be found the data for the years preceding 1899. The data for 1899 and 1900 are also added to this table, since these have not been previously published, and relate to years in which beets have been grown on a commercial scale in the State.

The average climatic conditions of the northern half of the State are decidedly favorable for the development of the beet sugar industry. In the southern counties the higher autumn temperature and rainfall tend to prolong the growing period of the beet, and while in favorable seasons we have secured some good beets from southern Indiana, the average climatic conditions are such that the risk of low grade beets is too great, and the area of suitable soil is also quite limited as compared with the northern portion of the State.

FUEL.

No section in the beet belt has better facilities for securing fuel at reasonable rates than northern Indiana. There are numer-

TABLE XXVIII.

Average temperature for 17 years. Degrees Fahrenheit.

Counties	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Southern..	31.0	33.2	41.7	55.5	64.4	73.8	76.7	74.8	68.3	55.2	43.8	35.8	54.6
Central...	27.3	29.6	38.3	52.1	62.1	72.0	74.9	72.4	66.5	54.0	40.7	32.7	51.9
Northern.	24.3	27.5	34.3	50.2	60.4	70.8	73.2	71.6	65.1	52.7	38.9	30.0	50.0
AVERAGE TEMPERATURE, 1899.													
Southern..	31.3	23.7	41.1	56.0	66.4	75.2	76.7	77.8	66.0	61.2	49.3	32.9	54.8
Central..	29.0	22.1	37.3	53.8	63.9	73.2	74.9	75.9	66.1	58.8	45.3	30.0	52.5
Northern	25.4	20.0	34.0	53.5	62.8	72.2	73.6	74.6	63.7	57.5	43.4	28.3	50.8
AVERAGE TEMPERATURE, 1900.													
Southern..	35.0	30.1	39.8	54.6	66.3	73.3	77.8	80.8	73.2	63.7	45.8	36.4	56.4
Central...	32.4	26.4	36.1	52.1	64.5	70.9	75.3	78.2	69.8	61.6	42.3	32.7	53.5
Northern.	30.4	23.1	31.0	50.6	63.5	69.2	73.6	77.2	67.8	60.4	40.2	30.4	51.4
AVERAGE PRECIPITATION FOR 17 YEARS.													
Southern..	3.83	3.84	4.23	3.69	4.06	4.28	3.52	3.44	3.11	2.60	4.18	2.84	43.62
Central...	3.07	3.00	3.36	3.21	4.05	3.89	3.24	3.24	3.12	1.95	3.85	2.63	39.07
Northern.	2.41	2.56	2.55	2.79	4.43	3.79	3.18	2.88	2.99	2.28	3.43	2.22	35.51
AVERAGE PRECIPITATION, 1899.													
Southern..	4.03	2.60	5.47	2.58	4.46	4.29	3.15	4.12	1.17	2.87	2.82	3.67	41.19
Central...	3.44	2.24	4.23	1.53	3.44	2.18	3.08	2.83	1.54	2.71	2.65	2.92	32.79
Northern.	2.22	1.98	3.67	0.75	3.98	2.12	3.62	2.15	2.53	3.14	2.16	2.89	31.18
AVERAGE PRECIPITATION, 1900.													
Southern..	2.75	3.97	1.79	1.68	4.62	6.07	4.58	2.56	2.04	2.63	4.56	1.81	39.06
Central. .	1.64	3.59	2.21	1.47	5.56	5.40	4.91	3.51	2.32	2.46	3.80	1.18	38.05
Northern.	0.73	3.74	2.18	1.76	3.71	5.15	4.50	4.17	1.83	2.59	4.42	0.61	35.34

ous railroads that go directly to the coal fields of southern Indiana and Illinois, and pipe lines for both crude oil and natural gas cross the counties best adapted for beet raising.

WATER.

There is an abundant supply of water from lakes, streams and wells. The northern counties contain great areas of land very suitable for beet raising, which have only recently been drained, and where the permanent water levels are only a few feet below the surface. Along the shores of many of the lakes flowing wells are in use. All examinations of the waters that have been made show them to be of suitable quality for beet fac-

tory purposes, and to be of much better quality for this purpose than the waters used by the beet factories west of the Mississippi.

LIME ROCK.

There is an abundance of lime rock of good grade in northern Indiana. Large quantities of lime are produced at Delphi and Huntington, and smaller quantities at various points. The rock at Momence was investigated and found to contain too much material, not lime, to make it economical for the production of lime.

FACTORIES.

American engineering enterprise has developed the best sugar beet machinery and the best factory arrangements in the world. The question of suitable factory resolves itself into the question of securing the necessary capital to buy the factory. The bounty provisions in neighboring States have doubtless caused capital to be invested in these States rather than in Indiana. But the fact that Indiana is now producing beets for some of the factories in other States, makes it probable that in the near future factories will be located in Indiana.

TRANSPORTATION FACILITIES.

No section of the country is better supplied with railroad facilities than northern Indiana. A glance at a railroad map shows lines running in every direction, and there are very few points that are ten miles from a railroad station. In the thirty miles between the Kankakee river and Michigan City, ten railroad lines cross the Monon road. The great drainage ditches that have recently been dug for the purpose of draining extensive areas, are canals in size, and since the height of the water in them can be controlled to some extent, it would be possible to utilize some of them for transportation of beets in flat boats. Most of the roads are sandy and wet weather improves rather than injures them for heavy loads.

MARKETS.

The nearness to Chicago and Indianapolis and other distributing points in Indiana, insures the distribution of the sugar under the most favorable conditions. There are large numbers of farmers who ship milk to Chicago or who sell it to local creameries, and the beet pulp is valuable feed for dairy cattle and

becomes available at a time when pasturage ceases. In addition to dairy cattle, the beef cattle and hogs could be profitably fattened on a ration which would include beet pulp. All the conditions for the successful establishment of beet factories are present in northern Indiana, and they would doubtless have been in operation here, had it not been for the bounty inducements held out by neighboring States.

AVERAGE RESULTS OF TESTS IN DIFFERENT COUNTIES.

For convenience of reference the counties are arranged in alphabetical order. Heretofore we have avoided publishing averages, because in any single year we believed that results might be misleading. In the earlier work great difficulty was experienced in getting farmers to follow directions in regard to preparation of soil, and distance of planting, there was also a tendency to send in the largest beet for analysis. Where averages are taken of several samples improperly raised and sampled, and of only one or two properly produced, the result does not represent the capacity of the county to produce sugar beets. In the last five years there has been a marked improvement in this respect.. The difficulty mentioned above is still a factor, but the number of properly raised samples is much larger. The detailed statement for the average of different counties, shows the number of years and the number of samples entering into the average, so that it is possible to form a better opinion of the real significance of the average figures in each case. These averages are not to be taken as a final statement of the suitability of many counties for beet culture. They simply record the facts that we have obtained. In some cases where a considerable number of samples have been secured in several different years, the results doubtless give a fair indication of what may be expected in these counties. In other cases the results must be considered in connection with the known conditions of soil and climate, because the number of samples secured is not great enough to serve as a basis of a fair estimate. These cases will be discussed in connection with the results from each county.

The results are stated in terms of the percentage of sugar in the juice. The usual contract terms for beets are based on beets that contain 12.7 per cent of sugar in the juice (12 per cent in the beet) and a purity coefficient of 80; but most factories accept beets of lower quality than this, sometimes as low as 10 per cent of sugar in the beet and a purity of 70. Where beets are

sold on a sliding scale these beets of low quality of course are sold at a reduced price.

YIELDS.

We have not reported yields because in most cases no yield has been given and in some cases it was evident that in calculating the yield some grave error has been committed since some of the yields were beyond the range of possibility.

Adams County.—Two samples in two years.

Sugar, 14.3 per cent.
Purity, 78.6 per cent.

This county is well within the beet belt and the soils are of proper character.

Allen County.—Eighty-one samples in six years.

Sugar, 12.5 per cent.
Purity, 81.0 per cent.

This county is well adapted for beet culture. The average is reduced by some very poor beets, not properly raised that were received in 1891. Excluding these, the results become:—

Sugar, 13.2 per cent.
Purity, 82.7 per cent.

Bartholomew County.—Three samples in two years.

Sugar, 11.5 per cent.
Purity, 80.4 per cent.

This county is not in the beet belt, and most of its soil is too heavy for beet culture.

Benton County.—Three samples in two years.

Sugar, 12.8 per cent.
Purity, 82.4 per cent.

Dr. H. W. Wiley has conducted a number of tests in this county, and there is no doubt that there is an abundance of land in the county on which satisfactory beets could be grown at moderate cost.

Blackford County.—One sample.

Sugar, 9.3 per cent.
Purity, 75.6 per cent.

The sample was grown on muck land which seldom produces good beets. The soil and situation of the county are suitable for beet culture.

Boone County.—Seven samples in two years.

Sugar 13.7 per cent.
Purity, 83.9 per cent.

This county is on the southern border of the beet belt. There is considerable land in the county, on which satisfactory beets can be produced.

Carroll County—Ten samples in four years.
Sugar, 12.5 per cent.
Purity, 79.6 per cent.

Much of the land in this county is rather heavy for beet culture, but there are considerable areas of suitable land. Lime stone is abundant.

Cass County.—Sixteen samples in five years.
Sugar, 12.4 per cent.
Purity, 80.5 per cent.

Portions of this county are suited to beet culture, while in other parts the soil is too heavy.

Clay County.—One sample.
Sugar, 9.1 per cent.
Purity, 67.9 per cent.

Neither soil nor location is favorable.

Clinton County.—Thirty samples in four years.
Sugar, 12.1 per cent.
Purity, 81.3 per cent.

This county has the conditions to make a better showing than the above results indicate.

Crawford County. —One sample.
Sugar, 9.8 per cent.
Purity, 83. per cent.

Neither soil nor location is favorable.

Daviess County.—Four samples in two years.
Sugar, 13.9 per cent.
Purity, 82.6 per cent.

This county is too far removed from the beet belt to be a promising field for beet culture.

Delaware County.—Five samples in three years.
Sugar, 12.1 per cent.
Purity, 83.2 per cent.

Neither soil nor location favorable.

Decatur County.—Two samples in one year.
Sugar, 14.2 per cent.
Purity, 81.3 per cent.

The soils of this county are too heavy for beet raising.

DeKalb County.—Five samples in two years.

Sugar, 14.1 per cent.

Purity, 84.1 per cent.

Soils and location are favorable.

Delaware County.—Five samples in five years.

Sugar, 11.8 per cent.

Purity, 79.9 per cent.

Soil and location fairly favorable.

Elkhart County.—Thirteen samples in four years.

Sugar, 13.3 per cent.

Purity, 78.3 per cent.

This county has soil and climate very well adapted for beet culture. The results above do not fairly represent the county since the average is reduced by some very poor samples sent in 1892. The results in the other three years gave an average of 14.4 per cent of sugar.

Fayette County.—One sample.

Sugar, 18.1 per cent.

Purity, 87.4 per cent.

The county is not suited for beet culture on account of its heavy soils. The above results show what sort of beets are often produced on clay. But they are small, and the cost of production is too high.

Floyd County.—Five samples in two years.

Sugar, 8.7 per cent.

Purity, 67.7 per cent.

Location and soil both unfavorable.

Franklin County.—Four samples in four years.

Sugar, 11.2 per cent.

Purity, 74.7 per cent.

The soils of this county are too heavy for beet culture.

Fountain County.—Two samples in two years.

Sugar, 10.3 per cent.

Purity, 72.6 per cent.

There are some good beet lands in this county, but very little attention has been paid to the matter.

Fulton County.—Five samples in three years.

Sugar, 12.9 per cent.

Purity, 83. per cent.

Soils and situation favorable.

Grant County.—Eleven samples in six years.

Sugar, 14.0 per cent.

Purity, 82.2 per cent.

Satisfactory beets were received in all of the six years. Soil and location favorable.

Greene County.—Five samples in three years.

Sugar, 11.7 per cent.
Purity, 83.3 per cent.

There are considerable areas of land in this county that are suitable for beet production, but the soils are strong and the situation of the county is such that beets would not be likely to mature well.

Hamilton County.—Eighteen samples in three years.

Sugar, 11.7 per cent.
Purity, 76.3 per cent.

This county is on the southern edge of the beet belt. The land in the northern part of the county ought to produce good beets.

Hancock County.—Five samples in two years.

Sugar, 12.9 per cent.
Purity, 86.2 per cent.

All the samples were from the extreme northwest part of the county.

Harrison County.—Four samples in three years.

Sugar, 10.8 per cent.
Purity, 72.6 per cent.

Soil and location unfavorable.

Hendricks County.—Nine samples in two years.

Sugar, 9.7 per cent.
Purity, 75.8 per cent.

Soil is favorable for economical beet production, but beets are not likely to mature well.

Henry County.—Sixteen samples in five years.

Sugar, 12.3 per cent.
Purity, 81.5 per cent.

Excluding one bad lot in 1900, the average becomes—

Sugar, 13.2 per cent.
Purity, 83.1 per cent.

The county has suitable soil and considerable interest was manifested in beet culture in 1897, when farmers expressed a willingness to contract to raise beets for factory purposes.

Howard County.—Eleven samples in six years.

Sugar, 11.0 per cent.
Purity, 76.8 per cent.

The location and soils of the county ought to be favorable for beet culture, but the samples received have not been very encouraging.

Huntington County.—Twenty-one samples in three years.

Sugar, 14.3 per cent.
Purity, 80.7 per cent.

Location and soil in a part of the county are favorable. Lime stone is abundant.

Jackson County. —Seven samples in three years.

Sugar, 10.3 per cent.
Purity, 71.3 per cent.

There are considerable areas of light soil in this county, but the fall season is not favorable to maturing beets.

Jasper County. —Six samples in four years.

Sugar, 13.4 per cent.
Purity, 82.1 per cent.

The county is very well adapted for beet culture.

Jay County. —Ten samples in four years.

Sugar, 13.7 per cent.
Purity, 81.1 per cent.

The county is fairly adapted for beet culture.

Jefferson County.—Four samples in three years.

Sugar, 10.6 per cent.
Purity, 74.1 per cent.

Neither soil nor climate suitable for beet culture.

Jennings County.—One sample.

Sugar, 10.3 per cent.
Purity, 74.0 per cent.

Neither soil nor climate suitable for beet culture.

Johnson County.—Six samples in one year.

Sugar, 10.5 per cent.
Purity, 80.1 per cent.

These beets were grown in 1898 and failed to ripen. While there is suitable land in the county, it is probable that late ripening would prove a hindrance to success.

Knox County.—One sample.

Sugar, 6.0 per cent.
Purity, 60.6 per cent.

Neither soil nor climate suitable for beet culture.

Kosciusko County.—Twenty-seven samples in six years.

Sugar, 12.4 per cent.
Purity, 79.7 per cent.

The soil and climate are satisfactory. All but two of the samples were raised previous to 1895, and the county can produce satisfactory beets under proper methods of cultivation.

LaGrange County.—Eight samples in four years.

Sugar, 14.1 per cent.
Purity, 82.5 per cent.

The county is well adapted for beet culture.

Lake County.—Fifteen samples in five years.

Sugar, 12.8 per cent.
Purity, 81.1 per cent.

The soil and climate are very suitable for beet culture. I personally drew a number of samples in this county, and they were raised under the most unfavorable conditions.

LaPorte County.—Five samples in one year.

Sugar, 13.9 per cent.
Purity, 85.6 per cent.

Soil and climate are both favorable to beet culture.

Madison County.—Five samples in four years.

Sugar, 12.1 per cent.
Purity, 77.3 per cent.

This county is on the southern border of the beet belt and contains land suitable for beet culture.

Marion County.—Thirty-three samples in seven years.

Sugar, 12.6 per cent.
Purity, 79.6 per cent.

This county contains suitable land, but there would be danger of trouble on account of late ripening.

Marshall County.—Fifteen samples in four years.

Sugar, 13.6 per cent.
Purity, 82.5 per cent.

The county is well adapted to beet culture.

Martin County.—One sample.

Sugar, 9.4 per cent.
Purity, 70. per cent.

Not adapted to beet culture.

Miami County.—Three samples in three years.

Sugar, 13.3 per cent.
Purity, 81.3 per cent.

The county is well adapted to beet culture.

Monroe County.—Six samples in three years.

Sugar, 13.6 per cent.
Purity, 84.1 per cent.

While good beets have been produced in this county, most of the soils are too heavy and the county is too far south for successful beet culture.

Montgomery County.—Two samples in two years.

Sugar, 10.8 per cent.

Purity, 72.4 per cent.

This county is on the southern border of the beet belt, and contains considerable land suitable for beet raising.

Morgan County.—Twenty-four samples in two years.

Sugar, 12.0 per cent.

Purity, 81.6 per cent.

There are considerable areas of suitable land in this county, but late ripening would be likely to cause trouble.

Newton County.—Six samples in four years.

Sugar, 11.1 per cent.

Purity, 80.6 per cent.

The county has satisfactory land and climate for beet raising. The above figures include some early results with doubtful seed. There is no doubt that excellent beets can be grown in the county.

Noble County.—Seven samples in four years.

Sugar, 12.5 per cent.

Purity, 80.5 per cent.

This county is well situated for beet raising.

Ohio County.—One sample.

Sugar, 12.7 per cent.

Purity, 81.4 per cent.

This county is not favorably located for beet culture.

Owen County.—One sample.

Sugar, 9.4 per cent.

Purity, 80.3 per cent.

Not adapted to beet raising.

Parke County.—Four samples in two years.

Sugar, 10.2 per cent.

Purity, 68.2 per cent.

It is not likely that beet raising would be profitable in the greater part of the county.

Perry County.—Two samples in one year.

Sugar, 12.4

Purity, 78.5 per cent.

Both soil and location unfavorable to beet culture.

Porter County.—Seventeen samples in six years.

Sugar, 13.1 per cent.

Purity, 80.9 per cent.

The conditions in this county are very favorable to beet production.

Pulaski County. –Ten samples in three years.

Sugar, 13.7 per cent.

Purity, 86.1 per cent.

Both soil and climate conditions are very favorable to beet culture.

Putnam County.—Three samples in one year.

Sugar, 8.1 per cent.

Purity, 71.6 per cent.

Most of the soils in this county are too heavy for beet culture and there would probably be trouble on account of later ripening.

Randolph County. –Five samples in three years.

Sugar, 12.7 per cent.

Purity, 80.5 per cent.

There is considerable land in this county that is suitable for beet raising, and the climatic conditions are fair.

Ripley County.—One sample.

Sugar, 12.2 per cent.

Purity, 77.8 per cent.

Neither soil nor climate are favorable to beet culture.

Rush County.—One sample.

Sugar, 9.0 per cent.

Purity, 72.0 per cent.

It is not probable that beet culture would be generally successful in this county on account of heavy soils and tendency to late ripening.

Scott County.—Two samples in one year.

Sugar, 4.5 per cent.

Purity, 51. per cent.

Neither soil nor climate favorable.

Shelby County.—Ten samples in five years.

Sugar, 11.9 per cent.

Purity, 77.9 per cent.

While some of the soils in this county are suitable, there would probably be trouble on account of late ripening.

Spencer County.—Two samples in two years.

Sugar, 10.9 per cent.

Purity, 73.6 per cent.

Neither soil nor climate favorable.

Starke County.—One hundred and ten samples in five years.

Sugar, 14.5 per cent.

Purity, 87. per cent.

This county is admirably adapted to sugar culture. We have conducted considerable special work in this county, and the results show that beets of the best quality can be produced at low expense and that the beets ripen early and the soil is so porous that there is little tendency to start a second growth when the fall rains begin. Doubtless the same would be found true in the surrounding counties.

St. Joseph County.—Twenty-one samples in five years.

Sugar, 13.2 per cent.

Purity, 79.1 per cent.

Both soil and climate are very well adapted for beet culture.

Steuben County.—Six samples in three years.

Sugar, 14.5 per cent.

Purity, 84.7 per cent.

Both soil and climate well suited for beet culture.

Sullivan County.—One sample.

Sugar, 9.5 per cent.

Purity, 75.4 per cent.

Neither soil nor climate favorable.

Switzerland County.—Three samples in three years.

Sugar, 13.4 per cent.

Purity, 82.3 per cent.

The location of this county is such that beet raising is not likely to be successful.

Tippecanoe County.—Two hundred and ninety-seven samples in twelve years.

Sugar, 12.3 per cent.

Purity, 82.2 per cent.

Practically all these samples were raised on the Station farm which is a second bottom underlaid with gravel and very susceptible to drouth. The above record includes many samples of varieties of sugar beets that no one would think of raising for commercial purposes. During the earlier years we had some difficulty in getting good seed and much of the commercial seed purchased, showed by comparison with seed of known good

quality, that the commercial seed was hardly entitled to be considered seed of sugar beets. Of late years good seed has been easily obtained, and the comparison of five year periods shows the effect of this. Thus 131 samples raised here between 1892 and 1896 show—

Sugar, 11.5 per cent.
Purity, 80.9 per cent.

While 90 samples between 1897 and 1901 show—

Sugar, 13.9 per cent.
Purity, 85.3 per cent.

These figures are hardly comparable with the tests in other counties, because we have never had less than five varieties of beets each year, of which some were not well suited to our soil, while to other counties we furnished seed most likely to do well on the soils that experimenters said that they would use. There is an abundance of land in the county that is well suited for beet culture, and climate conditions are satisfactory. This is the only county in the State having a continuous record since 1888. The above record does not include a large number of samples on which special fertilizer work was conducted.

Tipton County.—Twenty-six samples in five years.

Sugar, 12.2 per cent.
Purity, 80.3 per cent.

Soil and climate are favorable. The low figures are due to bad results previous to 1895. Twenty samples in 1897 and 1898 show—

Sugar, 13.3 per cent.
Purity, 84.9 per cent.

Vanderburg County.—Thirty-eight samples in two years.

Sugar, 10.5 per cent.
Purity, 78.9 per cent.

While there is considerable land in this county that looks suited to beet culture, so far as our tests extend, the beets do not ripen. The autumn temperature and rainfall are too high.

Vermillion County.—Two samples in one year.

Sugar, 10.0 per cent.
Purity, 77. per cent.

This county is near the southern border of the beet belt. It contains considerable land suitable for beet culture, and is peculiar in having an exceptionally long river frontage. Coal is abundant. It deserves further investigation in regard to its capacity for beet production.

Vigo County.—Four samples in two years.

Sugar, 14.0 per cent.

Purity, 84.2 per cent.

This county is on the southern border of the beet belt and in the coal region. Much of the soil is rather heavy for beet culture.

Wabash County.—Ten samples in four years.

Sugar, 12.8 per cent.

Purity, 76.7 per cent.

This county is favorably situated and can doubtless produce much better beets than the average figures indicate.

Warren County.—One sample.

Sugar, 12.2 per cent.

Purity, 83. per cent.

The county has considerable amount of land suitable for beet raising, and is close to the Danville coal fields.

Wayne County.—Eight samples in two years.

Sugar, 13.9 per cent.

Purity, 83.1 per cent.

This county contains considerable land suited for beet culture.

Wells County.—Two samples in two years.

Sugar, 11.4 per cent.

Purity, 74.5 per cent.

This county has suitable climate and soil. The samples were raised in 1892 and 1893. The county ought to produce good beets.

White County.—Three samples in three years.

Sugar, 12.5 per cent.

Purity, 75.9 per cent.

This county has suitable soil and climate for beet raising. The low average is due to a very poor sample, variety unknown, received in 1897.

Whitley County.—Eight samples in three years.

Sugar, 11.8 per cent.

Purity, 79.7 per cent.

This county is favorably located for beet culture. The low average is due to some bad samples of beets raised from poor seed in 1894.

APPENDIX.

Gifts have been made to the Station from time to time, and acknowledgment is herewith made to the friends of the Station for their favors, with thanks for the same. Gifts have been received from the following:

Syracuse Plow Co., Syracuse, N. Y. One three section spring tooth harrow.

Executors of the late Willis Manor House, Carperby, Arysgarth, England. Wensleydale wool.

Sutton & Sons, Reading, England, Cabinet and Vasculum of grass seeds. Copy of Sutton's book on Pastures.

Clem Graves, Bunker Hill, Ind. Plaster model of Hereford bull "Dale."

German Kali Works, N. Y. Potash salts.

United States Department of Agriculture, Washington. Many agricultural publications and seeds.

Bucher & Gibbs Plow Co., Canton, Ohio. One plow.

Our Husbands Mfg. Co., Lyndon, Vt. One Common Sense Calf Feeder.

Hallock Weeder and Cultivator Co., York, Pa. One Weeder.

Propaganda for Nitrate of Soda, New York City. 1200 lbs. Nitrate of Soda.

Farbenfabriken of Eberfeld Co., New York. Two Vials of Alinit.

H. R. Bussler, Waterloo, Neb. One package Pencillaria Zeavides.

Mrs. R. D. Moore, LaFayette, Collection Miscellaneous Agricultural books.

Joseph E. Wing, Secretary, Mechanicsburg, Ohio, Vol. I Continental Dorset Sheep Record.

C. R. Thomas, Secretary, Kansas City, Mo., Vol. XXII American Hereford Record.

F. L. Houghhton, Secretary, Brattleboro, Vt., Vols. 17 and 18, Holstein -Friesian Herd book.

W. H. Morris, Secretary, Indianapolis, Ind., Vols. 19, 20 and 21 of Central Poland China Record.

Carl Friegau, Secretary, Dayton, Ohio, Vol. 7 American Chester White Record.

Geo. F. Woodworth, Secretary, Maryville, Mo., Vols 10-14 inclusive, Standard Poland China Record.

Dwight Lincoln, Secretary, Milford Center, Ohio, Vol. 2 American Rambouillet Sheep Record.

AGRICULTURAL PERIODICALS.

The publishers of the following periodicals have generously sent them free to the Station during the year. These are leading journals and are used frequently by all persons coming in contact with our library.

American Agriculturist....................New York, N. Y.
American Creamery..........................Chicago, Ill.
American Grange Bulletin.................Cincinnati, Ohio.
American Horticulturist...................Wichita, Kansas.
American Sheep Breeder and Wool Grower......Chicago, Ill.
American Swineherd..........................Chicago, Ill.
Baltimore Sun (weekly)......................Baltimore, Md.
Beet Sugar Gazette..........................Chicago, Ill.
Breeders' Gazette.............................Chicago, Ill.
California Cultivator......................Los Angeles, Cal.
Chicago Dairy Produce.......................Chicago, Ill.
Chicago Live Stock World...................Chicago, Ill.
Colman's Rural World.......................St. Louis, Mo.
Creamery Gazette........................Des Moines, Iowa.
Creamery Journal...........................Waterloo, Iowa.
Dairy and Creamery..........................Chicago, Ill.
Dairy and Produce Review...............San Francisco, Cal.
Dakota Field and Farm...................Sioux Falls, S. D.
Drainage Journal.........................Indianapolis, Ind.
Drovers' Journal.............................Chicago, Ill.
Elgin Dairy Report..........................Elgin, Iowa.
Experiment Station Record................Washington, D. C.
Farm and Dairy...............................Ames, Iowa.
Farm and Fireside........................Springfield, Ohio.
Farm and Home...............................Chicago, Ill.
Farm, Field and Fireside....................Chicago, Ill.
Farm Journal...............................Philadelphia, Pa.
Farm Poultry................................Boston, Mass.
Farmers' Call.................................Quincy, Ill
Farmers' Guide...........................Huntington, Ind.
Farmers' Home..............................Dayton, Ohio.
Farmers' Review.............................Chicago, Ill.
Farmers' Tribune........................Des Moines, Iowa.
Farmers' Voice..............................Chicago, Ill.
Feather, The............................Washington, D. C.
Field and Farm..............................Denver, Col.

Flour and Feed..............................Waukegan, Ill.
Gazette (weekly)..........................Cincinnati, Ohio.
Golden Egg..................................St. Louis, Mo.
Grange Visitor.............................Lansing, Mich.
Home and Farm..........................Louisville, Ky.
Hospodarska Listy.............................Chicago, Ill.
Indiana Farmer..........................Indianapolis, Ind.
Iowa Homestead........................Des Moines, Iowa.
Journal of Agriculture.......................St. Louis, Mo.
Kansas Farmer...........................Topeka, Kansas.
Live Stock Journal.............................Chicago, Ill.
Louisiana Planter.......................New Orleans, La.
Market Garden.........................Minneapolis, Minn.
Mirror and Farmer.....................Manchester, N. H.
Montana Fruit Grower....................Missoula, Mont.
National Farmer and Stock Grower..National Stock Yards, Ill.
National Stockman and Farmer...............Pittsburg, Pa.
Nebraska Farmer...........................Lincoln, Neb.
New England Farmer........................Boston, Mass.
New York Produce Review................New York, N. Y.
Ohio Farmer..............................Cleveland, Ohio.
Orange Judd Farmer..........................Chicago, Ill.
Operative Miller..............................Chicago, Ill.
Oregon Agriculturist........................Portland, Ore.
Our Horticultural Visitor.Kinmundy, Ill., Benton Harbor, Mich.
Pacific Homestead..............................Salem, Ore.
Pacific Rural Press.....................San Francisco, Cal.
Practical Dairyman......................Indianapolis, Ind.
Practical Farmer.........................Philadelphia, Pa.
Prairie Farmer...............................Chicago, Ill.
Public Ledger (daily)......................Philadelphia, Pa.
Reliable Poultry Journal.......................Quincy, Ill.
Rural Northwest.............................Portland, Ore.
Southern Farm Magazine...................Baltimore, Md.
Southern Planter...........................Richmond, Va.
Southern States............................Baltimore, Md.
Sugar Beet...............................Philadelphia, Pa.
Swine Breeders' Journal.................Indianapolis, Ind.
Tippecanoe Farmer.........................LaFayette, Ind.
Wallace's Farmer........................Des Moines, Iowa.
Western Creamery.....................San Francisco, Cal.
Western Fruit Grower.....................St. Joseph, Mo.

Western Horseman........................Indianapolis, Ind.
West Virginia Farm Review..............Charleston, W. Va
Wisconsin Agriculturist........................Racine, Wis.
Wool Markets and Sheep......................Chicago, Ill.

INDIANA PERIODICALS.

Advertiser ....Medaryville.
American Standard...............................Frankfort.
Banner ....Bluffton.
Columbia City Mail...........................Columbia City.
Democrat ....Salem.
Home Journal.....................................LaFayette.
Hoosier State.....................................Newport.
LaFayette Commercial Gazette..................LaFayette.
Lyons' Herald......................................Lyons.
Magnet ....Angola.
Mennonitische Rundschau.........................Elkhart.
News ....Monon
Record...Rising Sun
Register..Crown Point.
Silent Hoosier....................................Indianapolis.

FOREIGN.

Agricultural Gazette of New South Wales....Sidney, Australia.
Co-Operative Farming.........................Sussex, N. B.
Farmers' Advocate.........................London, Ontario.
Farming................................Toronto, Canada.
Queensland Agricultural Journal..........Brisbane, Australia.

Besides the above, the following periodicals are on file in the Station library as regular subscription journals:

American Veterinary Review..............New York, N. Y.
Berichte der Deutschen Botanischen Gessellschaft..Berlin, Ger.
Botanisches Centralblatt..........Cassel-Marburg, Germany.
Botanische Zeitung.......................Leipsig, Germany.
Bulletin de la Societe Chemique de Paris........Paris, France.
Centrallblatt fur Bakteriologie................Jena, Germany.
The Entomologist.........................London, England.
Gardeners' Chronicle......................London, England.
Journal fur Landwirthschaft................Berlin, Germany.
Journal of Comparative Medicine............Philadelphia, Pa.
Journal of the Royal Agricultural Society of England..London.
Journal of the Chemical Society............London, England.
Live Stock Journal, The..................London, England.
Veterinarian, The.........................London, England.
Zeitschrift fur Analytische Chemie......Weisbaden, Germany
Station, Farm and Dairy............Sidney, New South Wales.

FINANCIAL STATEMENT.

Treasurer's Report.

Receipts from Experiment Station funds for the year ending June 30, 1901:

From United States Treasurer	$15,000.00
From Experiment Farm	1,599.37
Total	$16,599.37

JAMES M. FOWLER,
Treasurer Board of Trustees.

Secretary's Report.

The Agricultural Experiment Station of Indiana in account with the United States for the year ending June 30, 1901:

DEBIT.		
Received of the United States Treasurer	$15,000.00	
CREDIT.		
Salaries		$ 9,086.97
Labor		1,919.14
Publications		812.10
Postage and stationery		106.21
Freight and express		122.20
Heat, light, water and power		656.72
Chemical supplies		45.24
Seeds, plants and sundry supplies		700.39
Fertilizers		8.63
Feeding stuffs		793.38
Library		100.55
Tools, implements and machinery		350.08
Furniture and fixtures		11.00
Scientific apparatus		6.09
Live stock		140.00
Traveling expenses		49.65
Contingent expenses		11.77
Buildings and repairs		79.88
Totals	$15,000.00	$15,000.00

The above is a correct statement of expenditures from the Station Fund, for the year ending June 30, 1901.

ERWARD A. ELLSWORTH,
Secretary Board of Trustees.

Improvement Fund, Experiment Farm for year ending June 30, 1901.

DEBIT.		
Balance June 30, 1901	$ 433.30	
Farm receipts for 1901	1,599.37	
CREDIT		
Salaries		$ 262.79
Labor		918.90
Seeds, plants and sundry supplies		10.75
Feeding stuffs		42.60
Live stock		83.43
Contingent expenses		80.00
Balance		634.20
Totals	$2,032.67	$2,032.67

The above is a correct statement of expenditures from the Improvement Fund for the year ending June 30, 1901.

EDWARD A. ELLSWORTH,
Secretary Board of Trustees.

PURDUE UNIVERSITY.

Fifteenth Annual Report

OF THE

Indiana Agricultural Experiment Station.

LAFAYETTE, INDIANA.

For the Year Ending June 30, 1902.

To the Governor:

I transmit herewith the annual report of the Purdue University Agricultural Experiment Station for the year ending June 30, 1902.

December 21, 1902.

WILLIAM V. STUART,
President of the Board of Trustees.

To the President of the Board of Trustees:

I herewith present the fifteenth annual report of the Agricultural Experiment Station of Indiana for the year ending June 30, 1902, the same being required by Section 3, of an act entitled "An act to establish Agricultural Experiment Stations in connection with the Colleges established in the several States, under provisions of an act approved July 1862, and of the acts supplemental thereto," and being in accordance also with the instructions of the Department of Agriculture.

This report consists of a report of the Director of the Station, a summary of Station investigations by members of the staff, and a financial report of the Secretary to the Board of Trustees.

WINTHROP E. STONE,
President.

December 21, 1902.

BOARD OF CONTROL.

William V. Stuart, President........LaFayette, Tippecanoe Co.
William A. Banks.......................LaPorte, LaPorte Co.
Sylvester Johnson......................Irvington, Marion Co.
David E. Beem..........................Spencer, Owen Co.
Job H. VanNatta.................LaFayette, Tippecanoe Co.
William H. O'Brien.............Lawrenceburg, Dearborn Co.
James M. Barrett......................Fort Wayne, Allen Co.
Charles Downing...................Greenfield, Hancock Co.
Charles B. Stemen..................Fort Wayne, Allen Co.

Edward A. Ellsworth, Secretary,
James M. Fowler, Treasurer.

STATION STAFF.

Winthrop E .Stone, A. M. Ph. D.....President of he University

Charles S. Plumb, B. S............................Director
William C. Latta, M. S.........................Agriculturist
James Troop, M. S.............................Horticulturist
Henry A. Huston, A. M., A. C.......................Chemist
Joseph C. Arthur, D. Sc............................Botanist
Arvill W. Bitting, M. D., D. V. M...............Veterinarian
William Stuart, M. S.................Associate Horticulturist
F. S. Johnston, B. S. in Agr...........Associate Agriculturist
H. E. VanNorman, B. S..........................Dairyman
A. N. Hume, B. S. in Agr.............Assistant Agriculturist
Herman B. Dorner, B. S...................Assistant Botanist
R. C. Obrecht, B. S. in Agr..........Farm Superintendent
and Assistant in Animal Husbandry

FIFTEENTH ANNUAL REPORT

OF THE

Indiana Agricultural Experiment Station

FOR THE YEAR ENDING JUNE 30, 1902.

REPORT OF THE DIRECTOR.

To President W. E. Stone:

Sir:—I herewith submit the Fifteenth Annual Report of this Station for the year ending June 30, 1902.

The most important change in the work of the Station during this year has occurred in the Horticultural Department, as outlined in my report of last year. Mr. Stuart has given his entire time to vegetable gardening, while Professor Troop has looked after the fruit interests. Believing it wise to work in a limited field relating to some important state crop, it has been thought best for Mr. Stuart to make a special study and investigation of water and musk melon problems, giving but little time to other work. This has taken up several phases. During the fall and winter, melons and cucumbers were grown in the greenhouse with more or less success to study the effect of the use of plant food on these crops, and the effect of different soils. Incidentally, varieties also received attention. This spring and summer, cultural and fertilizer experiments with melons are being conducted on our home grounds, while co-operative experiments are in progress on two melon farms, with special melon soil, a few miles west of here on Sand Ridge near the Wabash bottoms, on the

farms of Messrs. Frazier and O'Brien. The month of June has been one of unusual coolness and moisture, which fact coupled with an invasion of insects has introduced serious problems in getting returns from the melon work, yet it is my opinion that this line of investigation will prove of much value to our melon growers. Mr. Stuart has made one trip into the melon region of the State this spring, and is securing the attention and interest of melon growers, as is quite desirable. At the suggestion of the writer, the Soil Division of the United States Department of Agriculture will conduct a soil survey of melon lands during the summer of 1902 in Posey county in this state.

In order to serve the farmers in the region about LaFayette, beginning with July, the Station introduced a new plan of sending out on rural mail wagons weather forecasts, as issued daily by the Weather Service. This consisted in having made a number of sets of sheet iron, painted flags of the color and general proportions of the Weather Service flags. One set of these was turned over to each rural route carrier. Each morning the carrier places on each side of his wagon one or two of these metal flags, which are fastened thereon by hooks. As the wagon passes along the country highways, the farmer conveniently located to the road may observe these signals for some distance, and so become advised of the weather prospects for the ensuing 24 hours. This is the first attempt of the kind that has yet been undertaken in the United States. The LaFayette Posmaster regards this experiment as generally satisfactory in a way, this expressing the opinion of the rural carriers and patrons. A serious criticism however, relates to this system, in that the signals given are the reports received at LaFayette at midnight, and are for the day the carrier is on his route.

As the routes are long, one being 27 miles, patrons at the beginning of the route get the full benefit of the service, while those of the latter half of the route receive reports so delayed that the service is quite defective. It is rather difficult, however, to improve this side of the service.

As a result of the conference of the writer and Professor

Johnston with some of the members of the Indiana Seed Corn Growers' Association, the Station has inaugurated some co-operative experiments in Johnson county on the farms of several members of this Association. The work of selecting the seed and ground, and supervising the planting, was personally attended to by Professor Johnson. This work involves a movement in the way of improving corn by selection and breeding, seeking a greater protein content in the seed, and also some cultural experiments. The local conditions for conducting the work are very superior in character of soil and lay of land. Further—those co-operating with the Station are among the most progressive farmers and corn growers in Indiana. It is hoped that considerable practical and useful experimental data will be secured from this work.

Swine feeding experiments have been continuously carried on during the entire year. One experiment on the effect of tankage as a food for swine reported in bulletin form, attracted much attention from all over the United States, and Swift & Co., the Chicago packers, purchased 5,000 copies of this bulletin to distribute to their patrons. During the winter a second experiment on the same subject was conducted, and the pigs fed were shown at the Inter-national Live Stock Exposition at Chicago in December, and later slaughtered at the packing house of Armour & Co. These pigs presented a striking appearance in favor of tankage as a supplementary food and we were the recipients of much attention at this great exposition.

Some feeding experimental work has been in progress this year on the value of dried distillery grains as a food for horses, but with results rather unfavorable to the grains.

The two greenhouses used for experimental work have been mainly given up to hot house vegetables this season, the subjects of soil fertility, soil moisture and class of soil, being more or less under observation on muskmelons, cucumbers, tomatoes and lettuce.

Pot culture work has been conducted in the Botanical department with soy beans and cow peas in particular, using different standard soils, and also studying the effect of bacterial

development in the soil. This spring a sack of soil innoculated with soy bean bacteria was sent to this Station by the kindness of the Kansas Experimental Station, and experimental innoculation of our soil is being made from this source. Last season a German bacterial preparation of Alinit was used in pot culture work on both oats and corn, but with entirely negative results.

The general work of the Station has proceeded in an orderly and quiet way, with no essential changes over preceeding years. Limited funds will not permit any expansion at present outside of a rather restricted field of work.

The Station Staff has undergone several changes. Mr. J. H. Skinner, the Assistant Agriculturist, resigned to accept a position in the College of Agriculture of the Illinois University. Mr. Skinner was a valuable assistant, whose services contributed to the successful work of the Station. During the past year, Mr. A. N. Hume, a graduate of the School of Agriculture at Purdue, has acted as half time Assistant Agriculturist in a very acceptable manner. Mr. R. C. Obrecht, a graduate of the Iowa Agricultural College in 1901, has also acted as an Assistant to the Director during the past year, and also has served as Farm Superintendent, giving faithful attention to his duties.

The Station mailing list is now in the second year of its revision, and contains a greater percentage of live addresses than our list has for some years. On June 30, 1902, this list was classified as follows

Names of persons in Indiana	6,407
Names of persons in other states	1,011
Names of persons in foreign countries	159
Indiana Periodicals	748
Periodicals outside of Indiana	131
Total	8,456

Publications have been issued during the year as follows:

PAMPHLET BULLETINS.

Bulletin No. 89, Vol. XI, July, 1901, pp. 39-70. The source of milk supply for towns and cities. By A. W. Bitting, D. V. M., M. D., Veterinarian.

Bulletin No. 90. Vol. XI, October, 1901, pp. 71-82. (By some error this bulletin was paged 205-216). Tankage as a food for pigs. By C. S. Plumb, Director, and H. E. VanNorman, Assistant.

Bulletin No. 91, Vol. XI, January, 1902, pp. 83-106. The modern silo. By C. S. Plumb, Director.

Bulletin No. 92, Vol. XI, April, 1902, pp. 107-116. Fertilizer tests on tomatoes. By H. A. Huston, Chemist.

Bulletin No. 93, Vol. XI, June, 1902, pp. 8. The influence of condimental foods in fattening swine. By C. S. Plumb Director.

NEWSPAPER BULLETINS.

No. 92. August 13, 1901. Silage and late fall pasture and feed. By C. S. Plumb, Director.

No. 93, August 20, 1901. Infectious Ophalmia in cattle. By R. A. Craig, D. V. M., Assistant State Veterinarian.

No. 94, September 17, 1901. Vaccination as a preventive of black leg. By R. A. Craig, D. V. M., Assistant State Veterinarian.

No. 95, September 26, 1901. Sheep scab.

No. 96, November 12, 1901. Results from fertilizers on corn in dry seasons. By A. N. Hume, Assistant Agriculturist.

No. 97, November 23, 1901. Corn stalk disease. By A. W. Bitting, D. V. M., Veterinarian.

No. 98 December 2, 1901. Corn smut and disease. By A. W. Bitting, D. V. M., Veterinarian.

No 98 (Duplication of number), May 13, 1902. Stable disinfection. By A. W. Bitting, D. V. M., Veterinarian.

No. 99, May 23, 1902. Clean cold milk. By H. E. Van Norman, Dairyman.

No. 100, May 27, 1902. The Experiment Station and its work. By C. S. Plumb, director.

No. 101, May 29, 1902. Sorrel. By J. C. Arthur, Botanist.

ANNUAL REPORT.

Fourteenth Annual Report of the Indiana Agricultural Experiment Station, for the year ending June 30, 1901, pp. 112, Plates IV, fig. 1, map 1.

There has been a constant demand for the publications of the Station. A number of copies of Bulletin No. 89 on the source of milk supply for towns and cities, have been sent on request, to officers of Boards of Health in various parts of the country, who have desired them for distribution among milk producers. Bulletin No. 91, on the Modern Silo, has also been much in demand from over a wide territory. The newspaper bulletins have also met with an appreciative reception by not only our state journals but also by numerous agricultural papers published in other states.

Respectfully Submitted,

C. S. PLUMB,

July 7, 1902. Director.

APPENDIX.

Gifts have been made to the Station from time to time, and acknowledgment is herewith made to the givers, for their favors, with thanks for the same. Gifts have been received from the following:

Ripley Hardware Co., Grafton, Ill. One gallon of fly remover, and sprayer for applying the same.

H. W. Doughten, Moorestown, N. J. One gallon of fly killer oil and glass reservoir sprayer.

Benj. Hammond, Fishkill-On- Hudson, N. Y. One gallon "Cattle Comfort."

Sprague Commission Co., Chicago, Ill. One gallon "Fly Bouncer."

Vail Seed Co., Indianapolis, Ind. One gallon "Eli Fli-Chaser."

Chas. H. Childs & Co., Utica, N. Y. So-Bos-So Kilfly and one Electric Sprayer.

Shoo-Fly Manufacturing Co., Philadelphia, Pa. One gallon "Shoo-Fly" and one sprayer.

E. W. Wilcox, Secretary, Hugo, Minn. Vol. I American Yorkshire Record.

Alfred Mansell & Co., Secretaries, Shrewsbury, England, Vol. XIX English Shropshire Flock Book.

J. M. Thorburn & Co., New York City. Sample of Excelsior Rye.

J. A. Everitt, Indianapolis, Ind. Sample of Mastodon white rye.

Glucose Sugar Refining Co., Chicago, Ill. 35 bottles of product from Indian corn.

National Milk Sugar Co., New York City. 35 lbs. Albumen poultry feed.

E. Rauh & Sons Fertilizer Co., Indianapolis, Ind. 100 lbs. each of pure raw bone meal and acid phosphate.

Pasteur Vaccine Co., Chicago, Ill. One gallon Lincoln Sheep Dip and one quart of disinfectant.

Smith Creamo Metre Co., Indianapolis, Ind. One creamo metre.

Moore Chemical and Manufacturing Co, Kansas City, Mo. Four gallons hog remedy, one gallon sheep dip, one gallon cattle dip.

J. W. LaGrange, Franklin, Ind. One volume of Western Holstein Friesian Herd Book.

Chicago Flexible Shaft Co., Chicago, Ill. One set of photographs and shears for 1902 sheep shearing machine.

B. F. Richardson, Dubuque, Iowa. Photograph and sample Angora fleece.

N. W. Ayer & Son, Philadelphia, Pa. One manual of newspapers of the United States for 1902.

AGRICULTURAL PERIODICALS.

The publishers of the following periodicals have generously sent them free to the Station during the year. These are leading journals and are frequently used by all persons coming in contact with our library:

Agricultural Experiments	Minneapolis, Minn.
American Agriculturist	New York, N. Y.
American Fertilizer	Philadelphia, Pa.
American Grange Bulletin	Cincinnati, Ohio
American Horticulturist	Wichita, Kansas
American Swineherd	Chicago, Ill.
Baltimore Sun (Weekly)	Baltimore, Md.
Beet Sugar Gazette	Chicago, Ill.
Breeder's Gazette	Chicago, Ill.
California Cultivator	Los Angeles, Cal.
Chicago Dairy Produce	Chicago, Ill.
Chicago Live Stock World	Chicago, Ill.
Colman's Rural World	St. Louis, Mo.
Creamery Gazette	Des Moines, Iowa
Creamery Journal	Waterloo, Iowa
Dairy and Creamery	Chicago, Ill.
Dairy and Produce Review	San Francisco, Cal.
Dakota Farmer	Fargo, N. D.
Dakota Field and Farm	Sioux Falls, S. D.
Drainage Journal	Indianapolis, Ind.
Drovers' Journal	Indianapolis, Ind.
Elgin Dairy Report	Chicago, Ill
Experiment Station Record	Washington, D. C.
Farm and Fireside	Springfield, Ohio
Farm and Home	Chicago, Ill.
Farm, Field and Fireside	Chicago, Ill.
Farm Journal	Philadelphia, Pa.
Farm Poultry	Boston, Mass
Farmers' Call	Quincy, Ill.

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Farmers' Review........................Chicago, Ill.
Farmers' Tribune........................Des Moines, Iowa
Farmers' Voice........................Chicago, Ill.
The Feather........................Washington, D. C.
Field and Farm........................Denver, Colo
Flour and Feed........................Waukegan, Ill.
Gazette (Weekly)........................Cincinnati, Ohio
Hoard's Dairyman........................Fort Atkinson, Wis.
Home and Farm........................Louisville, Ky.
Hospodarska Listy........................Chicago, Ill.
Indiana Farmer........................Indianapolis, Ind.
Iowa Homestead........................Des Moines, Iowa
Journal of Agriculture........................St. Louis, Mo.
Kansas Farmer........................Topeka, Kansas
Live Stock Journal........................Chicago, Ill.
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National Stockman and Farmer........................Pittsburg, Pa.
Nebraska Farmer........................Lincoln, Neb.
New England Farmer........................Boston, Mass
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Ohio Farmer........................Cleveland, Ohio
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Operative Miller........................Chicago, Ill.
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Pacific Rural Press........................San Francisco, Cal.
Practical Farmer........................Philadelphia, Pa.
Prairie Farmer........................Chicago, Ill.
Public Ledger (Daily)........................Philadelphia, Pa.
Reliable Poultry Journal........................Quincy, Ill.
Southern Farm Magazine........................Baltimore, Md.
Southern Planter........................Richmond, Va.
Southern States........................Baltimore, Md.

Strawberry Specialist..........................Kittrell, N. C.
Sugar Beet...............................Philadelphia, Pa
Swine Breeders' Journal....................Indianapolis, Ind.
Wrade, The...............................Baltimore, Md.
Wallace's Farmer.........................Des Moines, Iowa
Western Horseman.......................Indianapolis, Ind.
West Virginia Farm Review.............Charleston, W. Va.
Wisconsin Agriculturist.........................Racine, Wis.
Wool Market and Sheep.......................Chicago, Ill.

Indiana Periodicals.

Advertiser .... Medaryville
American Standard..............................Frankfort
Banner.......... ....Bluffton
Columbia City Mail.........................Columbia City
Democrat......... ....Salem
Home Journal................................LaFayette
Hoosier State................................Newport
LaFayette Commercial Gazette...................LaFayette
Lyon's Herald.....................................Lyons
Magnet......... ....Angola
Mennonitische Rundschau........................Elkhart
News............. ....Monon
Progress-Examiner.......... ....Orleans
Record..................................Rising Sun
Register.................................Crown Point
Silent Hoosier..............................Indianapolis

Foreign.

Agricultural Gazette of New South Wales....Sidney, Australia
Co-operative Farming..........................Sussex, N. B.
Farmers' Advocate........................London, Ontario
Station, Farm and Dairy............Sidney, New South Wales
Queensland Agricultural Journal..........Brisbane, Australia

Besides the above, the following periodicals are on file in the Station Library as regular subscription journals:

Berichte der Deutschen-Botanischen Gessellschaft.........
.................................Berlin, Germany

Botanisches Centralblatt............Cassel-Marburg, Germany
Botaninsche Zeitung........................Leipsig, Germany
Bulletin de la Societe Chemique de Paris........Paris, France
Centrallblatt fur Bakteriologie.................Jena, Germany
The Entomologist.........................London, England
Gardners' Chronicle........................London, England
Journal of Botany.........................London, England
Journal fur Landwirthschaft..................Berlin, Germany
Journal of Comparative Medicine............Philadelphia, Pa.
Journal of Royal Agricultural Society of England........
..................................London, England
Journal of Chemical Society................London, England
Live Stock Journal, The....................London, England
Review Mycologie............................Paris, France
Veterinarian, The..........................London, England
Zeitschrift fur Analytische Chemie........Weisbaden, Germany

The reports of the different Departments were submitted after the resignation of Professor Plumb, and were arranged by Professor Huston.

REPORT OF THE AGRICULTURIST.

C. S. PLUMB, Director.

Sir:—I submit below a brief statement, relative to the work of the Department for the year ending June 30, last.

You are aware of the fact that I sustained, during the past year, only an advisory relation to the Department and that the work has really been done by others who are not now here.

RESULTS PUBLISHED.

No bulletins were published. Mr. Hume reported during the year for the Drovers' Journal of Chicago. This could hardly be classed, I think, under results published, though it doubtless referred in part to Station work.

RESULTS READY FOR PUBLICATION.

I have no matter in my hands ready for publication. The yields of corn, oats, and wheat for 1901 have been recorded and could soon be tabulated for publication if thought best. In my judgment there is little of especial interest to give to the public, relative to the work in my Department at the present time.

WORK STILL IN PROGRESS.

Most of the work of the Department is in an unfinished stage. In most cases some years will be required to get reliable results. The principal lines of work that are now in progress are: Tests of varieties of wheat, methods of cropping and fertilization; deep and shallow and thick and thin planting of corn; deep and shallow breaking for farm crops and co-operative experiments with farmers in Johnson County to determine the influence of breeding and selection on the yield and composition of corn. The last named was begun last spring.

WORK ABANDONED.

The test of varieties of oats, which was begun last spring, was abandoned through the serious lodging of the crop. The test of varieties of cow peas begun in the spring of 1902 was

also abandoned, owing to early frost. Results of this work would, however, belong to the annual report for the year ending June 30, 1903. No other work was abandoned.

NEWSPAPER BULLETINS.

The following newspaper bulletins were published during the year ending June 30, 1902:

"Results from fertilization on corn in dry seasons," by Albert N. Hume.

"Variety tests of winter wheat," by F. S. Johnston.

Very Respectfully Yours,

W. C. LATTA,

Agriculturist.

REPORT OF THE ASSOCIATE AGRICULTURIST.

C. S. PLUMB, Director.

Sir:—The work on the Station Farm has been done under the direction of the Associate Agriculturist, but is reported by the Agriculturist.

In the spring of 1902, work on the improvement of corn was taken up, in co-operation with L. B. Clore, H. M. Stout, and Whitesides, in Johnson County. The work includes field experiments covering a number of problems in method of production with the purpose of increasing the nitrogen content of the corn. It is the intention to extend the work on corn and to also take up co-operative work on forage crops in different parts of the state.

Very Respectfully Yours,

F. S. JOHNSTON,

Associate Agriculturist.

REPORT OF THE HORTICULTURIST.

C. S. PLUMB, Director.

Sir:—Among several experiments which have been running for several years in this Department may be mentioned (1)

Whole vs. piece root grafting; (2) The Stringfellow method of pruning; (3) Varietal tests of fruits.

The Division of Pomology, Department of Agriculture, Washington, D. C., has at several different times sent this Department a number of varieties of apple trees, each of which was grafted upon a whole root, a crown and a tip, making three trees of each variety. These have been grown in the Experimental orchard and careful notes taken of them. Some of the earlier set varieties bore their first fruit last season.

The Stringfellow method of pruning newly set trees has been practiced on apple, pear, peach, plum, cherry and quince. Some interesting results have been obtained which will be ready for publication a little later.

Besides some 85 varieties of strawberries, raspberries and blackberries, there have been tested 50 varieties of apples and pears and 15 varieties of plums and cherries. Most of the plums and cherries were Russian varieties and have proved to be unsuited to this locality. They were dug out this spring and other new varieties planted in their places.

Some extensive experiments were carried on last summer with Paris Green and Disparine as insecticides, resulting in the Disparine giving much the better results. Crude petroleum and whale oil soap were tested as to their efficiency against the San Jose scale. It was found that the whale oil soap could be used sufficiently strong to kill the scale without injuring the tree, while the crude petroleum would often injure the tree. The oil used came from the Huntington county, Indiana wells and tested about 33 degrees B. specific gravity—too heavy for purposes of this kind.

During the winter 1901-2 experiments were carried on with different varieties of tomatoes for forcing and also with sub- vs. surface irrigation, the results of which will be ready for publication later on.

Respectfully Submitted,

J. TROOP,
Horticulturist.

REPORT OF THE ASSOCIATE HORTICULTURIST.

C. S. PLUMB, Director.

Sir:—Complying with your request, I would say that under the head of results published, I have nothing to report other than the publication of two articles in the Academy of Science Proceedings, which properly speaking might be considered Station investigations.

Results ready for publication—none.

Work still in progress—**Fertilizer and soil experiments with** cucumbers and melons in the forcing house; also outdoor experiments with watermelons and muskmelons. The latter included investigations regarding influence of starting plants in the hotbeds and cold frames; plant protectors in the field vs. none; chemical fertilizers vs. barnyard manure; comparison of varieties, etc. Test of varieties of vegetables for the Department of Agriculture. The notes of this test I have forwarded to Washington.

Work suspended—none.

Work abandoned—none.

Newspaper bulletins—none.

Very Respectfully Yours,

WILLIAM STUART,

Associate Horticulturist.

REPORT OF THE CHEMIST.

C. S. PLUMB, Director.

Sir:—The Department has published one bulletin, No. 92, on Fertilizer tests on tomatoes.

Considerable additional material is at hand relating to unproductive black soils and as the edition of the bulletin on this subject has been exhausted while the demand for it still continues it would be well to issue another bulletin on this subject.

Additional field work was undertaken this spring on this subject on the farm leased by Mr. L. G. Nice about two miles north of the Tippecanoe County Farm. The special pur-

pose in view was the application of various compounds of potash and magnesia in order to study the effects of the different ingredients of kainit, which has given such profitable results on this class of lands. Wood ashes were also used on a considerable portion of the field.

The permanent water level of the field under experiment is only 1·5 inches below the surface, and hence the field presents a fine opportunity to study the question of water levels.

The co-operative work on sugar beets was suspended, owing to the destruction of the crop in May by improper cultivation when the plants were very small.

The rotation plats of the Agricultural Department, however, included sugar beets on one set of plats, and the Chemical Department will work these up to obtain the effect on the composition of the beets and prevalence of fungus disease of long continued use of manures and fertilizers.

Observations of effect of phosphates on the root rot of apple trees are still in progress.

The work on carbohydrates and on changes in corn on standing in the field was suspended owing to lack of any assistant in the Department.

I have arranged to co-operate with the Indiana Horticultural Society in the matter of fertilization of orchards in connection with their experimental orchard in Orange county.

The Chemical Department has also arranged to make examinations of the corn produced in the co-operative work which the Agricultural Department has taken up with several of the seed corn growers of the State.

Considerable miscellaneous work on identification of material sent in and on soils and waters has been done.

The correspondence of the Department is continually increasing, especially along the line of soil improvement and the use of fertilizers.

Very Respectfully Yours,

H. A. HUSTON,

Chemist.

REPORT OF THE BOTANIST.

C. S. PLUMB, Director.

Sir:—The Department of Botany has continued to work in its principal lines of pathology and physiology during the year ending June 30, 1902. During this time much interruption has been occasioned by the change of assistants. Mr. William Stuart, who has been connected with the Department several years, resigned on September 1, 1901. In his place was appointed Mr. Herman B. Dorner, who came to the position without special training for the work. He resigned July 1, 1902.

No bulletins were published during the year, but two articles were printed in the last annual report, which appeared in February, 1902. These were entitled "An Edible Fungus," and "Two Weeds: Horse Nettle and Buffalo Bur." About 200 copies of these articles were reprinted and separately distributed. In addition to these an important account of "Indoor tomato culture with chemical fertilizers," by the assistant, Mr. Stuart, was printed in the same report.

There are in the records of the Department sufficient data upon a number of subjects to make interesting and profitable reports. Some of the subjects are "Control of Cocklebur," "Pruning and Care of Shade Trees," "The Seed Potato and Its Treatment," etc. For none of these subjects, however, are the data yet arranged in form for publication.

The work upon which the larger amount of time is being expended is chiefly the study of root tubercles of the leguminous crops, especially of cow peas and soy beans, growing of tomatoes and lettuce with chemical fertilizers, gathering information about edible fungi and weeds, and investigations in the intricate problems of the several grain rusts.

Two lines of work have been abandoned for the present for lack of facilities to carry it ahead: The growing of mushrooms on a commercial scale and the subwatering of greenhouse benches.

Yours Respectfully,

J. C. ARTHUR,

Botanist.

REPORT OF THE VETERINARIAN.

C. S. PLUMB, Director.

Sir:—The work of the Veterinary Department for the past year has been almost wholly confined to the disease of sheep. The work has been conducted jointly between the Department and the office of the State Veterinarian; the latter giving the assistance of Dr. R. A. Craig, and affording opportunities for seeing affected flocks in different parts of the state, thus securing a larger range for observation than could be obtained in this locality. The results of the work are now in manuscript form ready for publication. The losses to the sheep industry have been unusually heavy during the past year; the literature upon the subject is meager and not available to farmers. It would seem that a bulletin along this line would be especially appropriate.

The Department has dropped the work upon hog cholera temporarily for lack of research facilities. The losses along this line will probably aggregate nearly $6,000,000 this year in this state. While much has been done in the study of the cause and prevention, the enormity of the loss warrants much more effort along experimental lines.

The lines along which it is most desirable that work be done are preventives for hog cholera and swine plague; the cause of the contagious eye disease in cattle and problems in stable sanitation. Respectfully submitted,

A. W. BITTING,
Veterinarian.

REPORT OF THE DAIRYMAN.

C. S. PLUMB, Director.

Sir:—I have not done any special experimental work during the year ending June 30, 1902. Have none in progress at present. I have given some time to routine work on records and have written one newspaper bulletin, besides letters and an occasional article. Very Respectfully Yours,

H. E. VAN NORMAN,
Dairyman.

FINANCIAL STATEMENT.

TREASURER'S REPORT.

Receipts from Experiment Station funds for the year ending June 30, 1902:

From United States Treasurer	$15,000.00
From Experiment Farm	2,672.28
Total	$17,672.28

JAMES M. FOWLER,
Treasurer Board of Trustees.

SECRETARY'S REPORT.

The Agricultural Experiment Station of Indiana in account with the United States for the year ending December 2, 1902:

DEBIT.

Received of the United States Treasurer	$15,000.00	
CREDIT.		
Salaries		$ 8,601.19
Labor		2,396.19
Publications		698.20
Postage and Stationery		77.57
Freight and Express		155.74
Heat, Light, Water and Power		504.31
Chemical Supplies		12.97
Seeds, Plants and Sundry Supplies		647.74
Fertilizers		7.25
Feeding Stuffs		817.29
Library		108.75
Tools, Implements and Machinery		304.85
Furniture and Fixtures		32.65
Scientific Apparatus		16.20
Live Stock		174.08
Traveling Expenses		117.76
Contingent Expenses		28.05
Buildings and Repairs		308.21
Balance		
Total	$15,000.00	$15,000.00

The above is a correct statement of expenditures from the Station Fund for the year ending June 30, 1902.

EDWARD A. ELLSWORTH,
Secretary Board of Trustees.

Improvement Fund, Experiment Farm for the year ending June 30, 1902:

DEBIT.		
Balance June 30, 1901	$ 634.20	
Farm Receipts for 1902	2,672.28	
CREDIT.		
Salaries		$ 788.71
Labor		902.97
Publications		64.15
Postage and Stationery		9.06
Freight and Express		8.14
Heat, Light, Water and Power		54.87
Seeds, Plants and Sundry Supplies		85.52
Feeding Stuffs		565.98
Tools, Implements and Machinery		65.66
Furniture and Fixtures		.75
Live Stock		63.05
Traveling Expenses		2.95
Contingent Expenses		84.42
Buildings and Repairs		7.75
Balance		602.50
Total	$3,306.48	$3,306.48

The above is a correct statement of expenditures from the improvement Fund for the year ending June 30, 1902.

EDWARD A. ELLSWORTH,
Secretary Board of Trustees.

PURDUE UNIVERSITY

Sixteenth Annual Report

OF THE

Indiana Agricultural Experiment Station

LAFAYETTE, INDIANA

For the year ending June 30, 1903

LAFAYETTE, IND.
PRESS OF BURT-TERRY-WILSON CO
1904

PURDUE UNIVERSITY

Sixteenth Annual Report

OF THE

Indiana Agricultural Experiment Station.

LAFAYETTE, INDIANA.

For the Year Ending June 30, 1903.

To the Governor:

I transmit herewith the annual report of the Purdue University Agricultural Experiment Station for the year ending June 30, 1903.

January 2, 1904.

WILLIAM V. STUART,
President of the Board of Trustees.

To the President of the Board of Trustees:

I herewith present the sixteenth annual report of the Agricultural Experiment Station of Indiana for the year ending June 30, 1903, the same being required by Section 3, of an act entited "An act to establish Agricultural Experiment Stations in connection with the Colleges established in the several States, under provisions of an act approved July, 1862, and of the acts supplemental thereto," and being in accordance also with the instructions of the Department of Agriculture.

This report consists of a report of the Director of the Station, a summary of Station investigations by members of the Staff, a list of the Station bulletins published prior to Feb. 1, 1904, and a financial report of the Secretary of the Board of Trustees.

WINTHROP E. STONE,
President.

January 2, 1904.

BOARD OF CONTROL.

William V. Stuart, President,	LaFayette, Tippecanoe Co.
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Edward A. Ellsworth, Secretary.
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STATION STAFF.

Winthrop E. Stone, A. M., Ph. D.	President of the University.
Arthur Goss, M. S., A. C.	Director and Chemist.
William C. Latta, M. S.,	Agriculturist.
James Troop, M. S.,	Horticulturist and Entomologist.
Joseph C. Arthur, D. Sc.,	Botanist.
Arvill W. Bitting, D. V. M., M. D.,	Veterinarian.
Hubert E. VanNorman, B. S.,	Dairyman.
John H. Skinner, B. S.,	Live Stock.
Alfred T. Wiancko, B. S. A.,	Associate Agriculturist.
William J. Jones, Jr., M. S., A. C.,	Assistant Chemist.
M. L. Fisher, B. S.,	Assistant Agriculturist.
R. M. Hamer,	Stockman.
Nellie Tracy,	Clerk and Librarian.

Table of Contents.

SIXTEENTH ANNUAL REPORT

OF THE

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION.

FOR THE YEAR ENDING JUNE 30, 1903.

REPORT OF THE DIRECTOR.

To President W. E. Stone:

Sir:—I take pleasure in submitting herewith the Sixteenth Annual Report of the Indiana Agricultural Experiment Station, the same covering the year ending June 30, 1903.

The Work of the Station.

In general, the same lines of work as heretofore have been carried on during the past year. A number of the investigations in progress, such as the experimental work, to determine the effect of continuous cropping as compared with a rotation of crops, and the effect of different methods of fertilization on the Station farm, have been running for several years, and in order to reach definite results must be carried on for a number of years longer. The information secured from experiments of this character is constantly accumulating and is published from time to time, whenever it becomes of sufficient importance to warrant.

It is confidently believed that such investigations as those mentioned above, the work on diseases of pigs which was carried on during the year, the investigations concerning the controlling of oat smut on a large scale, the improvement of the so-called bogus soils of the state, the testing of varieties of grains, fruits and vegetables and of different kinds of fertilizers in different localities, as well as many other investigations in progress at the Station, will prove to be not only of considerable scientific interest, but of very great financial advantage to the farmers of the state as well.

Owing to the very limited funds available, but little new work was undertaken during the year, and such as was taken up could only be started on a very small scale, and with the hope that sufficient funds would be provided to carry it on. Plans, however, have been prepared for a considerable extension of the Station work

along the line of new investigations at other points in the state, as there is a very great demand for the same. It is hoped that sufficient funds may be provided in the near future to carry out these plans.

A more detailed account of the work of the Station will be found in the reports from the different departments. On the whole, it is thought that quite as much was accomplished in the Station during the past year as could reasonably be expected, considering the limited funds available and the large number of changes that occured in the Station Staff.

Financial Needs of the Station.

In connection with this report, I deem it my duty as Director, to say a few words in regard to the very urgent financial needs of the Station.

By referring to the financial statement, it will be seen that the total income of the Station, during the year covered by this report, was $16,713.42. $15,000.00 of this was derived from the general government and $1,713.42 from the sale of farm products. Of the above amount $14,090,37 was used for the items:—salaries, labor, publications, gas and water, insurance, feeding stuffs, tools and machinery, and necessary repairs to buildings, fences, etc. This left only $1,804.05 with which to take care of all other fixed expenses, of which there are necessarily a large number, and to provide the necessary apparatus and facilities for the experimental work at the Station and all new work both at the Station and elsewhere in the state.

The Experiment Stations of our neighboring states, as well as of most other states of the Union, have much larger incomes with which to carry on their work. In the following table is given the income of some of the other stations, for the year covered by this report, in comparison with that of our own.

New York	$81,906.52
Illinois	70,712.16
Minnesota	70,709.12
Ohio	59,448.70
Kentucky	52,909.73
Louisiana	50,207.19
Indiana	16,713.42

From the above showing it is perfectly apparent that the Indiana Station cannot successfully compete with its neighbors until more funds are provided. As pointed out elsewhere, a large amount of valuable work is being, and has been done in the Indiana Station; but with an income of only one-third or one-fourth as much as our neighbors, practically all of which is used up in fixed expenses, it is utterly impossible to accomplish anything like

so much, as is accomplished by them, particularly in the line of co-operative extension work throughout the state. The following query is often proposed by farmers of the state and others: "They are doing such fine work along this or the other line of Station work in Illinois, Ohio, or some other neighboring state; why do you not do more in Indiana?" It is very humiliating to have to confess that our neighbors are in the lead in such matters, but considering the financial condition of our Station, the reason is obvious.

It has come to a point where the funds of this Station are entirely inadequate to provide even for the necessary running expenses, not to mention outside investigations. There is, for example, not enough money available at the present time to print the results of work already done, to say nothing of providing for new work. There has been in my possession, for some time past, completed and ready for printing, the manuscript for an exhaustive bulletin on diseases of pigs. The preparation of this bulletin occupied the time of the working force of the Veterinary Department for months. This material constitutes the most complete treatise in existence on the causes, symptoms and treatment of diseases of hogs. It would undoubtedly be of very great value, not only to Indiana farmers, but to the farmers throughout the country as well. This bulletin should undoubtedly be published, but to do so would require about $1,000, which at present is simply not available. When it comes to a point where the results of work already completed cannot be published, it would seem that something must be done to relieve the situation, and that speedily.

Then again, aside from the publishing of results, there is not a single department of the Station that is not at present very seriously hampered on account of lack of funds with which to carry on its work. It has, in my judgment, come to a point where one of two things must be done in order to successfully carry on the work of the Station, even as at present planned; either additional funds must be provided or else some of the work carried at present must be dropped.

It would seem that in as progressive a state as our own, and one containing such large agricultural interests, the latter alterntaive should not be considered for a moment. To discontinue any line of work now in progress would not only mean the cutting off of all investigations in that connection, but the loss of a large amount of past work as well; as in most lines of Station work reliable results can only be reached after years of preliminary investigation.

As to specific needs aside from the routine running expenses, perhaps the most important is that of a fixed income for conduct-

ing experimental and co-operative work at other points in the state, or extension work if it may be so called. It is highly important, for example, that investigations should be taken up concerning the soils and crops of different sections of the state. We now know fairly well as to what varieties and crops are best adapted to the soil of the Station farm at LaFayette, and what methods of fertilization and soil treatment are most successful here, but as the state contains very diversified soil conditions, particularly in its north and south extent, the knowledge gained from experiments at LaFayette, is unfortunately not applicable to many other sections.

In my opinion, a general agricultural survey of the different sections of the state, including not only work along the line of soils and crops, but embracing the Horticultural, Dairy, Live Stock, and other agricultural interests as well, would be of the highest importance to the state and should be started at the earliest possible moment.

Much of this work could best be carried on in co-operation with farmers of the state and with the different agricultural organizations, such as the State Dairy Association, the State Horticultural Society, the Corn Growers' Association, and others, but in order to wield the greatest influence and be of the highest value to all the farmers of the state, this work should all be united in one central organization, which logically should be the State Agricultural Experiment Station. The Station has already started this co-operative work in a few instances, but owing to lack of funds has so far been able to do little more than outline the work. In many of the states, liberal provision has been made for this important division of the experiment station work. In Illinois for example, the last General Assembly appropriated $54,000.00 for this extension work.

Another very urgent need of the Station at present is a fund with which to repair the greenhouses of the Horticultural and Botanical Departments and provide a satisfacory heating plant for the same. This is a matter that has been a constant source of annoyance. No adequate provision has heretofore been made for this purpose, with the result that the plants in the greenhouses are frequently frozen in the winter, thus rendering systematic investigations along these lines very uncertain. As the growing of vegetables under glass is coming to be a very important industry in the state, and as much of the experimental work of the Botanical Department is necessarily conducted in the greenhouse, it would seem that adequate provision should be made for this phase of the Station work.

Another need of the Botanical Department of the Station,

which I believe should be provided for at an early date, is a suitable pit in which to conduct experimental work in mushroom culture. Dr. Arthur says: "The mushroom industry is destined to be one of the great crop industries of the country, and this Station has long contemplated being one of the leaders in showing the importance of the crop and in devising practical methods for making it commercially successful in the hands of the ordinary cultivator. It is also hoped that we may be able to introduce new and untried varieties of superior excellence. This work is at a standstill at present for want of a suitable mushroom pit."

There is also urgent need of additional funds for the farm. The following is an extract from a report submitted by Professor Skinner in that connection: "The money available for use on the farm during the past year has not been sufficient to keep the buildings and fences in proper repair. There is urgent need for some 250 or 300 rods of first-class fencing on the farm. The sheep barn is small and old, and wholly unfitted for any experimental feeding. There must also be an addition to the hog barn before any large experiments can be carried on along this line. The buildings on the farm all need repairs and painting. There should also be additional stock for experimental purposes. The dairy herd is small and inadequate for any investigation of importance. Several of the cows are past their prime and should be replaced by good individuals which might serve for both experimental and college work. To put the Experiment Station plant for Animal Husbandy work in first-class condition, would require as can readily be seen a considerable sum of money."

The Station Library is also very badly in need of attention In fact, there may be said to be practically no Station Library at the present time. Aside from the bulletins from the other Stations, reports from the U. S. Department of Agriculture and other publications of that character, the Station owns few books of reference. If it were not for the fact that the different Sation workers are constantly drawiwng upon their own private funds for books which should properly be furnished by the Station, our library facilities would be in a still more deplorable condition. Then again, the cases for the bulletins and reports we already have are entirely inadequate for the purpose.

There is also very real need of a new Station building. The building now occupied, owing to the manner in which it is cut up into numerous small rooms, is very poorly adapted to the needs of the different Station laboratories. Owing to the lack of funds, the building when erected, was of such cheap and inferior construction that it settled and cracked to such an extent that it has all but fallen down and is, at the present moment, only held to-

gether by chains. It has several times been condemned as unsafe. This building is certainly, to say the least, not a credit to the state as one of its important public buildings.

The other needs of the Station are so very urgent, however, that I believe they should receive attention even before a new Station building is erected. With the expenditure of a small sum of money for repairs, the present building could possibly be made to answer a little while longer; provided it does not fall down in the meantime.

To summarize then, the most urgent needs of the Station at present, and those which should receive early attention, are:

1.—An increased annual income as an addition to the present income and for carrying on experimental co-operative and extension work in different sections of the state.

2.—Repairs to the greenhouses, an adequate heating plant for the same, and a suitable pit for experimental work in mushroom culture.

3.—Repairs and improvements on the farm.

4.—Additional equipment for the Library.

5.—Repairs in the Station building.

Changes in the Station Staff.

The past year has been characterized by a very unusual number of changes in the Station Staff. This was not due to any political upheaval or any other similar cause, the occurence of which is now practically impossible in the Indiana Station, but simply to the fact that an unusually large number of the working force resigned to accept positions of greater pecuniary advantage and broader usefulness elsewhere. It is very evident that high grade men, unless they have other ties to bind them, cannot be retained on the small salaries necessarily paid at this Station, under the present financial condition. During the twelve months covered by this report the Station has had three Directors.

Professor C. S. Plumb, who had served as Director since 1891, and whose work in connection with the dairy and live stock interests of the state has been of the greatest value, resigned September 1, to accept a position at the head of the Animal Husbandry Department of the Ohio State University.

Professor H. A. Huston, who had served in a most efficient manner as Chemist to the Station since its organization in 1888, and as State Chemist, and Professor of Agricultural Chemistry in Purdue University for a still longer period, was very appropriately chosen Director upon Professor Plumb's resignation. Unfortunately for the Station, Professor Huston was too valuable a man to be

retained, and after serving as Director but seven months, resigned to accept a more remunerative position in a broader field of work with the German Kali Works, with headquarters at St. Louis.

Professor Arthur Goss, a graduate of Purdue University in the class of 1888, who had served under Professor Huston as assistant chemist to the Station and assistant State Chemist from 1888 to 1892 and as Chemist to the New Mexico College of Agriculture and Mechanic Arts, and the New Mexico Agricultural Experiment Station, from 1892 to the time of election here, was chosen Director, Chemist to the Station and State Chemist, upon Professor Huston's resignation, April 1.

In the other Departments of the Station the changes in personnel of the working force were also unusually numerous.

Professor F. S. Johnston, who had served during the year previous as Associate Agriculturist, resigned September 1 to accept the position of Professor of Agriculture in the Texas Agricultural and Mechanical College, and Agriculturist in the Station.

Professor A. T. Wiancko, who was serving as Instructor in Agriculture in the University of Nebraska and Assistant Agriculturist in the Experiment Station, was elected Associate Agriculturist in the University and Station here, upon Professor Johnston's resignation.

Mr. A. N. Hume, Assistant Agriculturist, resigned August 1, to take charge of the Agricultural Department of the Winona School of Agriculture at Winona, Ind.

Professor J. H. Skinner, a graduate of Purdue, who was serving as Instructor in Animal Husbandry in the University of Illinois and who had previously been connected with this Station as Assistant Agriculturist, was, upon Professor Plumb's resignation, made Associate Professor of Animal Husbandry in the University, and placed in charge of that Department of the Station, as well as of the management of the Farm.

Mr. R. C. Obrecht, who had served the year previous as Superintendent of the Farm and Assistant in Animal Hubsandry was not retained upon Professor Plumb's resignation, owing to a different division of the work.

Mr. William Stuart, Associate Horticulturist, resigned September 1, to accept the position of Professor of Horticulture in the University of Vermont and Horticulturist to the Vermont Station.

Mr. W J. Jones, Jr., who had served since 1892 as Chief Deputy State Chemist, was also made Assistant Station Chemist September 1, when Professor Huston became Director.

Publications.

Publications have been issued as follows during the past year:

Phamphlet Bulletins.

Bulletin No. 94, Vol. 12, February, 1903, pp. 88. Diseases of Sheep. By A. W. Bitting and R. A. Craig.

Bulletin No. 95, Vol. 12, March, 1903, pp. 31. Unproductive Black Soils. By H. A. Huston.

Newspaper Bulletins.

No. 102, August 29, 1902, Variety Tests of Winter Wheat. By F. S. Johnston, Associate Agriculturist.

No. 103, September 8, 1902. Twisted Stomach Worms in Sheep. By A. W. Bitting, Veterinarian.

No. 104, November 25, 1902. The Hessian Fly—Information concerning its prevalence. By J. Troop, Horticulturist.

No. 105, December 11, 1902. Inflammation of the Brain and its membranes. Meningitis. Staggers. By R. A. Craig.

No. 106, December 26, 1902. Mange or Texas Itch among Horses. By R. A. Craig, Assistant State Veterinarian.

No. 107, May 20, 1903. Farmers' Picnic Excursion to Purdue University Agricultural Experiment Station, LaFayette, Ind., June 12, 1903. By Arthur Goss, Director.

No. 108, May 29, 1903. Sheep Scab obtained from the Stock Yards. By R. A. Craig, Assistant State Veterinarian.

No. 109, June 2, 1903. Alfalfa—Part 1. General Characteristics of the Crop. By Arthur Goss, Director.

No. 109, June 2, 1903. Alfalfa—Part 2. Its adaptation to Indiana. By Arthur Goss, Director.

Annual Report.

Fifteenth Annual Report of the Indiana Agricultural Experiment Station, LaFayette, Indiana, for the year ending June 30, 1902, pp. 24.

Mailing List.

On June 30, 1903, the Station mailing list was as follows:

Names of persons in Indiana	6,870
Names of persons in other states	1,293
Names of persons in foreign countries	173
Indiana periodicals	603
Periodicals outside of Indiana	144
Total	9,083

Respectfully submitted,

ARTHUR GOSS,

Director.

Report of the Agricultural Department.

To ARTHUR GOSS, Director,

Sir: The work of the Department of Agriculture for the past year upon the Station farm has been continued along the same general lines as in previous years. The most of the work was begun several years ago and much valuable information is being gathered which will be available for publication at some future time. The experiments with systems of cropping and fertilization are yielding interesting results and it is considered advisable to continue them for some time longer before conclusions should be drawn.

Twenty-four varieties of winter wheat, eight varieties of oats, six varieties of corn, nine varieties of soy beans, and five varieties of cow peas were tested during the year. New experiments with alfalfa and bromus inermis were begun; also an experimnet with corn to determine the effect of limited nutrition upon the percentage of barren stalks. This experiment will be continued for a series of years and is being conducted on a rather poor piece of ground, so that with the thickest planting, four stalks per hill, the amount of nourishment received by each stalk is very materially limited.

The cooperative experiments in corn breeding begun last year upon the farms of L. B. Clore, H. M. Stout and J. D. Whitesides in Johnson County, are being continued and similar experiments were begun this year upon the farms of Jacob Orth and Sons in Vigo County, J. V. McKnight in Fountain County and F. D. Hoopengardner in Wells County. Five varieties of corn are being used. The principal object of these experiments is to improve the feeding value of the corn. The cooperators are giving their part of the work careful attention, and substantial progress is being made.

Two other lines of cooperative experiments were begun this year, viz: A variety test of corn and a test of alfalfa under different conditions in various parts of the state. The cooperators are mostly ex-students of the Winter Course in the School of Agriculture, and the experiments are to be continued over a series of years. From six to ten leading varieties of corn are being tested as to their relative yielding power in twenty-five representative localities scattered all over the state. New seed will be supplied each year and the yields carefully determined. It is hoped that these experiments will lead to more careful attention to the selection of varieties suited to local conditions. The work with alfalfa is located in twenty representative localities in the state and its object is to determine the adaptability

of alfalfa to Indiana conditions. The seeding on each plat was done with and without a nurse crop and all plats were inoculated with soil containing the alfalfa bacteria. Reports as to the conditions of the plats will be collected from time to time and prepared for publication later.

There are a number of lines of investigation work of this kind which it would seem desirable to take up, in a cooperative way. For example, a study of the conditions for winter wheat growing and the selection of the best varieties for the soil and climatic conditions in the widely differing portions of the state, would be of great value. The value of the work which can be done on the Station farm along these lines is necessarily limited because the natural conditions are representative of only a small section of the state.

The Department has not published anything during the year except a press bulletin by Professor Johnston on the results of the variety tests with winter wheats. The Annual Report of 1899 contains a summary of the wheat experiments up to that time. The work in other lines not yet reported upon, has not been considered sufficiently advanced to warrant putting it into bulletin form.

Respectfully submitted,
A. T. WIANCKO,
Associate Agriculturist.

Report of the Horticultural Department.

To ARTHUR GOSS, Director,

Sir:—Several lines of work have been carried on by this Department during the past year, some of which are continuous of experiments begun several years ago and which will need to run some time yet in order to secure definite results. Among these may be mentioned one undertaken some years ago for the Department of Agriculture at Washington, on

Grafting the Apple on Whole vs. Piece Roots. This is an experiment to ascertain the relative influence on the growth and longevity of the tree resulting from grafting the scion on a whole or piece root. In this case several varieties were used, and three trees of each variety were grafted, one on a whole seedling root, one on the upper half of the root, and one on the lower half. These trees have now been planted four, five and six years; some have borne fruit, and up to the present time it is difficult to detect any marked difference in the character of the trees.

Long vs. Close Root-Pruning. This experiment also has been

running for several years. The question to be determined is this:—Is it necessary for a fruit tree to retain all of its roots, as it comes from the nursery, when planted out in the orchanrd? Three methods have been practiced, viz: (1) planting the whole root, (2) the Stringfellow method, which is to cut off *all* of the roots as well as the top, and (3) a modification of the latter, leaving three or four inches of the main roots, which serve to anchor the tree more firmly in the soil. Thus far our experiments show that peaches will do as well by the Stringfellow method, but for all others a modification of that method has produced the best results. Apples treated in this way have produced one-third more growth of top during the past year than those not pruned. This experiment will be continued indefinitely.

Manures for Orchards. Experiments are in progress both in the Station orchard and in the Experimental orchard, belonging to the State Horticultural Society, situated in Lawrence conuty, to test the effect of different commercial fertilizers when used in various combinations with each other, and also when used in connection with cow peas, soy beans and clover. This experiment was begun the past year, and will necessarily have to run for several years before reliable results are secured. In this connection I may add that experiments are now under way with a view of determining the cause and prevention of "Root-rot" in apple trees, which is so prevalent in the orchards of southern Indiana, resulting in the loss of hundreds of apple trees every year.

Spraying. Experiments in the comparative merits of Paris green and Disparine were continued the past year, with the same result as last year, viz:— with rains at frequent intervals during the early summer, one application of the Disparine, three pounds to 50 gallons of water, was as efficacious as three applications of Paris green, four ounces to 50 gallons of water, made at intervals of 10 days. Lime added to the Paris green solution gave better results, but not so good as the Disparine. However the expense of using Disparine is about two and one-half times as much as Paris green, not taking into account the extra labor.

The San Jose scale. Investigations have also been carried on during the past year in connection with the nursery inspection law, concerning the distribution of the San Jose scale in Indiana, resulting in the finding of this pest of the orchard in 32 counties in the state. Investigations are now in progress concerning various washes for use in its destruction.

Varietal tests. The usual varietal tests of all kinds of fruits and vegetables have been carried on and will be reported upon in detail in bulletins.

Forcing vegetables. A continuation of the experiments of last year along the line of sub- vs. surface irrigation of different

varieties of musk melons, cucumbers and tomatoes in the hot house were undertaken, but owning to a defect in the method of furnishing heat to the green house, no reliable results were secured.

Respectfully submitted,
J. TROOP,
Horticulturist.

Report of the Botanical Department.

To ARTHUR GOSS, Director,

Sir:—The work of the Botanical Department of the Station for the year ending June 30, 1903, has been chiefly in the study of parasitic and edible fungi.

1. *Cereal and other plant-rusts.* Considerable attention has been given to the plant-rusts, especially the grass and sedge forms. Rust produces the most destructive disease of cultivated crops, bringing about the greatest financial loss to the cultivator, and still no effective way has been found to control it. In attacking the problem a somewhat different method has been employed from that usually pursued. By a study of the forms on the wild grasses, it is hoped to show that many forms that have been accounted identical with the common grain rusts are really distinct, and should be eliminated from the problem. Many cultures in the green house were made during May and June, and with valuable results. The forms found on two wild grasses, *Eatonia Pennsylvanica* and *Bromus ciliatus*, heretofore called Puccinia *rubigo-vera*, and considered identical with the fall and spring rust of wheat, are proved to have their accidia on *Ranunculus abortivus* and *Dirca palustris* respectively, and therefore have no connection with wheat rust. In this way it is hoped to narrow the question down, and greatly simplify what is now a very intricate problem.

2. *Oat smut and its treatment.* A treatment for seed oats on an extensive scale to remove smut was tried on an estate about 50 miles from the Station. Formalin and sulphur fumes were used. About 150 bushels were treated at a time, and by an ingenious arrangement only 15 minutes were occupied in the application for each lot. The results were highly satisfactory. With the application of one pound of formalin to 116 bushels of seed grain, all smut was pratcically eliminated from the crop. The handling was that of common farm practice, yet only nine smutted stalks were found in a count of 3,000, made in various parts of the field, a number so small as to be accounted for by strays. A handful of the same seed sown in the test plats at the Station gave not a single stalk

showing smut. Untreated seed showed about five per cent of smut, a much smaller amount than Indiana oat crops usually show. This method can be applied at almost any large grain elevator, and at a cost so trifling as to be nearly or quite negligible. It promises to work a great advance in the methods of combatting an almost universal and important crop disease, and to save large sums to the farmers of the state.

3. *The wild mushroom crop.*—Mushrooms of a dozen or more kinds are very common, most seasons, throughout the state. Data have been gathered regarding some of the more abundant forms, that are easily recognizable, but not usually known to be edible. Beside notes upon their occurrence, characters, values as food, etc., photographs have been secured, with the view of eventually issuing a bulletin of information.

4. *Cow peas.* Through the initiative of the United States Department of Agriculture, a test of the Iron cow pea was made in comparison with the common blackeyed pea, to determine its resistent powers toward diseases. It is said not to be attacked by nematodes, but these do not occur in the soil on the Station farm. It was shown, however, to be entirely resistent toward rust, which prevailed on the other variety, but not on the Iron variety. Observations on its behavior toward the weevil have not yet been completed.

Respectfully submitted,

J. C. ARTHUR,
Botanist.

Report of the Chemical Department.

The work of the Chemical Department for the year ending June 30, 1903, has been, in brief, as follows:

1. The investigation started by Professor H. A. Huston, several years since, concerning the improvement of black muck, or so-called bogus, soils of the state was continued during the year and the results secured up to date were published in bulletin 95. The results of this work seem to clearly indicate two things in connection with the improvement of these soils: first—the necessity of thorough drainage, and second—the importance of applying potash-containing fertilizers; especially where, as is often the case, thorough drainage is impossible. This work is being continued as the results seem to be of sufficient importance to warrant further investigation.

2. The sugar beet work which has been carried on at this

Station at different times for several years past was continued this year in cooperation with the Chemical Bureau of the U. S. Department of Agriculture.

Plats were grown with and without irrigation, the beets being analyzed at weekly periods beginning September 14, and extending until November 19, when the beets were badly frozen and the investigation discontinued. As the rainfall this season was sufficient for beet production, there was practically no difference between the irrigated and non-irrigated plats. In a general way the yield and sugar content were quite satisfactory, averaging at the proper time of harvesting about 14 tons of beets per acre, with about 14.7 per cent of sugar in the juice .

3. An investigation concerning the development and composition of the corn plant at different stages of growth was started this spring. Samples of the corn were taken at weekly periods from germination to maturity. These were weighed and preserved for analysis. Photographs were also taken weekly to show the development of the crop. When the investigation is completed it is intended to publish the results secured, in bulletin form.

4. An investigation was started during the year, in cooperation with the Agricultural Department of the Station and a number of farmers of the state, in corn breeding. Samples of corn grown at different places in the state, from seed furnished by the Station, and in accordance with directions sent out from the Station, were sent to the Chemical Department for analysis. The principal aim of this work is to increase the protein content by analysis and selection, but the starch content and general composition of the samples have also been determined. The results secured are on file and will be published when sufficient data is secured to warrant. This work is being continued during the season of 1903.

5. As usual, a considerable number of miscellaneous analyses of feeding stuffs and other materials of importance to the farming interests of the state, were made during the year. The results secured are on file and available for publication at some future time.

6. An investigation concerning the fertilizer needs and chemical composition of the typical soils of the state was also started during the year. It is thought that this is an extremely important matter in this state at present. Owing to continuous cropping the fertility of the soils of the state is constantly decreasing and in many sections it is necessary at the present time to resort to artificial fertilization by the use of commercial fertilizers, or otherwise. The requests for information as to best methods of soil treatment and improvement are becoming more numerous all the while, and in order to supply anything like exact information in individual cases

it is necessary that more should be known concerning the typical soils of the state. This involves a soil survey of the state as to the chemical composition and fertilizer needs of, and the crops and varieties best adapted to, the soils of the different sections. Such an investigation will necessarily require several years time and the expenditure of a considerable amount of money, but it would seem to be well worth the trouble and expense. Owing to lack of funds, this work at present can only be carried on in a very limited and unsatisfactory manner.

ARTHUR GOSS, Chemist.

Report of the Veterinary Department.

To Arthur Goss, Director,

Sir:—The work of the Veterinary Department of the Experiment Station during the past year has been almost wholly confined to an investigation of the diseases of swine. This line of work has received a considerable part of our attention for the past ten years and the results have been brought together as a general treatise. The large amount of capital invested in the industry in this state and the severe loss that is annually sustained due to disease has pointed to this field as the one in which most good could be done for the largest number. The work has been carried out in greater detail than is usual in treatises upon swine diseases but the fact that thousands of individuals are selling from one to several hundred dollars worth of hogs annually indicates that the same care should be given to details as in a treatise upon diseases of horses or cattle.

A considerable part of this work has been made possible by cooperating with the office of the State Veterinarian. The description of the diseases as given from field work are largely the work of Dr. Craig, Assistant State Veterinarian.

The bulletin upon "Diseases of Sheep" prepared last year under a similar arrangement but published within this year, seems to have filled a want, as it has been called for in unusual numbers.

The department is in special need of a larger library. Without a knowledge of what others have done means loss of time, energy, and the making of mistakes that should be avoidable. There is also serious need of a place for keeping the experimental animals under Station control so as not to be dependent upon conditions as they may be found upon farm or where an outbreak exists. These needs have been suggested before.

Respectfully submitted,

A. W. BITTING, Veterinarian.

Report of the Animal Husbandry Department.

To ARTHUR GOSS, Director,

Sir:—The following report for the year ending June 30, 1903, is respectfully submitted:

Owing to the resignation of Professor C. S. Plumb as head of the Department of Animal Husbandry, investigations begun prior to September 1, 1902, were completed. At any rate no experimental work was in progress at that time. As soon as possible after taking up the work, experimental investigation was inaugurated in pig feeding and breeding, but data obtained to date was not sufficient for conclusions. The work on tankage feeding has been continued.

Investigation to determine the value of Yorkshire hogs for crossing and grading is in progress. Accurate breeding and feeding records of all live stock are being kept, as well as records of the amount and quality of milk from each individual in the dairy herd, in order to secure information as to breeding, feeding, production, etc.

The Station equipment for experimental work along animal husbandry lines is limited. With present facilities there is no opportunity for satisfactory experimental work with cattle and sheep, and as only such horses as are required for the farm work are kept, most of the investigational work of this Department must be confined to swine.

No cooperative experiments with farmers are possible, because of limited funds. Since the first of September, many inquiries for bulletins and information along live stock lines, have been answered.

The field for investigation in Animal Husbandry in Indiana is almost unlimited, as well as untouched. Many farmers are ready to cooperate with the Station when such work is possible. Much work should be done in the way of feeding and breeding on the Station farm, and the Department should be thoroughly organized and put on a substantial basis.

Farm.—The farm is in a good state of fertility. One hundred rods of new fencing has been erected. The following machinery and implements have been added to the equipment; 15 horse electric motor, manure spreader, corn planter, disc harrow, hay loader, cultivator, Planet Jr. drill, and several small tools. With a few exceptions the equipment of the farm so far as tools, implements, etc., are concerned, is good. We need additional horses.

Respectfully submitted,
J. H. SKINNER,
Animal Husbandryman.

Report of the Dairy Department.

To ARTHUR GOSS, Director,

Sir:—During the year ending June 30, 1903, the Dairy Department has been established in quarters in the new Agricultural Building, completed last September. Much time was given to planning and equipping the laboratories, so as to secure the greatest degree of usefulness for the work of experimentation and instruction. The apparatus is so grouped as to permit on the one hand, the carrying on of the various operations incident to butter making, as conducted in the ordinary creamery; on the other, is equipment for similar work on methods adapted to the farm dairy. With a view to obtaining milk for the use of the students, the University has employed a butter maker, and secured a supply of milk and cream for the making of butter, which has been placed on the general market. This work was begun in May, 1903. While the labor required in securing patrons and building up the business to the point where sufficient milk and cream is secured to meet the needs, has required most of the time so far, our laboratory is in shape to carry on a study of some of the problems which are perplexing the creamery men and dairymen of our state, and should the regular supply of milk from the farms of the vicinity and of hand separator cream brought in by rail be maintained or increased, the Department is in a position to take up these problems with very little additional expense. Among the important ones which are particularly needing attention at this time,—1—are methods of handling hand separator cream both on the farm, so as to secure its delivery in the best shape; and in the creamery, so as to secure a high grade of butter; 2—conditions influencing the moisture content of butter; 3—the desirable temperatures and other details in pasteurization of cream for butter-making.

During the year, bulletin No. 96, on the Care of Milk and Butter Making on the Farm, has been prepared and published. While this bulletin contained a report of little original work, it answered many of the questions which our people are asking and which has required considerable time in letter writing.

I would suggest the preparation in the near future, of a popular bulletin on somewhat similar lines covering the selection and feeding of milch cows on the average farm.

Some work has been done on the testing of milk sent to us for the purpose of determining the per cent of fat in it. We have also received a number of samples of butter which have been scored and criticisms and suggestions for improvement returned to the makers.

H. E. VAN NORMAN, Dairyman.

Appendix.

The publishers of the following periodicals have generously sent them free to the Station during the year. These are leading journals and are frequently used by all persons coming in contact with our library:—

Agricultural Periodicals.

Agricultural Advertising	Chicago, Ill.
Agricultural Experiments	Minneapolis, Minn.
American Agriculturist	New York, N. Y.
American Fertilizer	Philadelphia, Pa.
American Grange Bulletin	Cincinnati, Ohio.
American Horticulturist	Wichita, Kan.
American Swineherd	Chicago, Ill.
Baltimore Sun (Weekly)	Baltimore, Md.
Beet Sugar Gazette	Chicago, Ill.
Breeder's Gazette	Chicago, Ill.
California Cultivator	Los Angeles, Cali.
Campbell's Soil Culture	Lincoln, Neb.
Chicago Dairy Produce	Chicago, Ill.
Chicago Live Stock World	Chicago, Ill.
Colman's Rural World	St. Louis, Mo.
Commercial Poultry	Chicago, Ill.
Creamery Gazette	Des Moines, Iowa.
Creamery Journal	Waterloo, Iowa.
Dairy and Creamery	Chicago, Ill.
Dairy and Produce Review	San Francisco, Cali.
Dairy Record	St. Paul, Minn.
Dakota Farmer	Fargo, N. D.
Dakota Field and Farm	Sioux Falls, S. D.
Deutsch Amerikanischer Farmer	Lincoln, Neb.
Drainage Journal	Indianapolis, Ind.
Drovers' Journal	Chicago, Ill.
Elgin Dairy Report	Elgin, Ill.
Experiment Station Record	Washington, D. C.
Farm and Fireside	Springfield, Ohio.
Farm, Field and Fireside	Chicago, Ill.
Farm and Home	Chicago, Ill.
Farm, Stock and Home	Minneapolis, Minn.
Farm Journal	Philadelphia, Pa.
Farm Poultry	Boston, Mass.

Farmers' Call....................................Quincy, Ill.
Farmers' Guide..............................Huntington, Ind.
Farmers' Home...................................Dayton, Ohio.
Farmers' Review............................... Chicago, Ill.
Farmers' Sentinel............................Milwaukee, Wis.
Farmers' Tribune..........................Des Moines, Iowa.
Farmers' Voice...................................Chicago, Ill.
The Feather.................................Washington, D. C.
Field and Farm.................................Denver, Col.
Flour and Feed...............................Waukegan, Ill.
Hoard's Dairyman.........................Fort Atkinson, Wis.
Home and Farm..............................Louisville, Ky.
Hospodarska Listy..............................Chicago, Ill.
Indiana Farmer..............................Indianapolis, Ind.
Iowa Homestead..........................Des Moines, Iowa.
Journal of Agriculture.........................St. Louis, Mo.
Kansas Farmer..............................Topeka, Kansas.
Kimball's Dairy Farmer......................Waterloo, Iowa.
Live Stock and Dairy Journal.....................Fresno, Cali.
Live Stock Journal...............................Chicago, Ill.
Live Stock Journal..........................Indianapolis, Ind.
Louisiana Planter..........................New Orleans, La.
Mennonitische Rundschau.........................Elkhart, Ind.
Modern Farmer.............................St. Joseph, Mo.
National Stockman and Farmer..................Pittsburg, Pa.
Nebraska Farmer..............................Lincoln, Neb.
New England Farmer.........................Boston, Mass.
New York Produce Review....................New York, N. Y.
New York Tribune Farmer....................New York, N. Y.
Northwest Horticulturist.......................Tacoma, Wash.
Ohio Farmer.................................Cleveland, Ohio.
Orange Judd Farmer.............................Chicago, Ill.
Operative Miller.................................Chicago, Ill.
Oregon Agriculturist...........................Portland, Ore.
Our Horticultural Visitor..................Benton Harbor, Mich.
Pacific Rural Press........................San Francisco, Cal.
Practical Farmer.............................Philadelphia, Pa.
Prairie Farmer..................................Chicago, Ill.
Reliable Poultry Journal..........................Quincy, Ill.
Southern Farm Magazine.......................Baltimore, Md.
Southern Planter...............................Richmond, Va.
Southern States ....Baltimore, Md.
Strawberry Specialist...........................Kittrell, N. C.
Successful Farming.........................Des Moines, Iowa.

Sugar Beet..................................Philadelphia, Pa.
Swine Breeders' Journal......................Indianapolis, Ind.
Trade, The..................................Baltimore, Md.
Tri-State Farmer............................Chattanooga, Tenn.
Up to Date Farming..........................Indianapolis, Ind.
Wallace's Farmer............................Des Moines, Iowa.
Western Horseman............................Indianapolis, Ind.
West Virginia Farm Review...................Charlestown, W. Va.
Wisconsin Agriculturist.....................Racine, Wis.
Wool Markets and Sheep......................Chicago, Ill.

General Periodicals.

Advertiser..................................Medaryville, Ind.
American Standard...........................Frankfort, Ind.
Banner......................................Bluffton, Ind.
Columbia City Mail..........................Columbia City, Ind.
Democrat....................................Salem, Ind.
Enterprise..................................Wolcott, Ind.
Home Journal................................LaFayette, Ind.
Hoosier State...............................Newport, Ind.
LaFayette Commercial Gazette................LaFayette, Ind.
Lyon's Herald...............................Lyons, Ind.
News..Monon, Ind.
Public Press................................New Albany, Ind.
Recorder....................................Rising Sun, Ind.
Register....................................Crown Point, Ind.
Ripley Journal..............................Osgood, Ind.
Silent Hoosier..............................Indianapolis, Ind.
St. Louis Republic..........................St. Louis, Mo.

Foreign Periodicals.

Agricultural Gazette of New South Wales.......Sidney, Australia.
Agricultural Journal and Mining Record............Natal, S. A.
Co-Operative Farming..........................Sussex, N. B.
Farmers' Advocate.............................London, Ontario.
Journal of the Royal Horticultural Society......London, England.
Station Farm and Dairy..............Sidney, New South Wales.
Transvaal Agricultural Journal....................Pretoria, S. A.
Queensland Agricultural Journal.............Brisbane, Australia.

Besides the above, the following periodicals are on file in the Station Library as regular subscription journals:—

Berichte der Deutschen-Botanischen Gesselschaft.........
.... Berlin, Germany.
Botanisches Centralblatt..............Cassel-Marburg, Germany.
Botanische Zeitung............................Leipsig, Germany.
Bulletin de la Societe Chemique de Paris............Paris, France.
Centrallblatt fur Bakteriologie...................Jena, Germany.
Chemiker Zeitung............................Cothen, Germany.
The Entomologist............................London, England.
Gardener's Chronicle..........................London, England.
Journal of Botany............................London, England.
Journal fur Landwirthschaft...................Berlin, Germany.
Journal of Comparative Medicine and Veterinary
Archives ....Philadelphia, Pa.
Journal of the Royal Agricultural Society of England................................ London, England.
Journal of the Chemical Society...............London, England.
Landwirthschaftlichen Versuchs-Stationen.......Berlin, Germany.
Live Stock Journal............................London, England.
Review Mycologie............................London, England.
Veterinarian................................ London, England.
Veterinary Journal............................London, England.
Zeitschrift fur Analytische Chemie ....Weisbaden, Germany.

LIST OF BULLETINS.

Published by

The Indiana Agricultural Experiment Station,

To February 1, 1904.

Bulletins of the School of Agriculture.

*Bulletin No. 1, January, 1885, pp. 10, pl. II. The Hessian fly. By F. M. Webster.

*Bulletin No. 2, January, 1885, pp. 12. Experiments with nitrogenous, phosphatic and other fertilizers. By W. C. Latta.

*Bulletin No. 3, April, 1885, pp. 8, pl. III. Insects affecting growing wheat. By F. M. Webster.

*Supply exhausted.

*Bulletin No. 4, September, 1885, pp. 12. Experiments with wheat. By W. C. Latta.

*Bulletin No. 5, November, 1885, pp. 12, pl. II. Experiments with small fruits. By James Troop.

*Bulletin No. 6, March, 1886, pp. 16. Experiments with oats and corn. By W. C. Latta.

*Bulletin No. 7, 1886, pp. 12. Commercial fertilizers and notes on agricultural chemistry. By R. B. Warder.

*Bulletin No. 8, August 24, 1886, pp. 16. Experiments with wheat. By W. C. Latta.

*Bulletin No. 9, October 30, 1886, pp. 8, pl. I. The American Meromyza. By F. M. Webster.

*Bulletin No. 10, December 15, 1886, pp. 8. Report of the director of the Indiana State Horticultural experiment Stations. By James Troop.

*Bulletin No. 11, 1887, pp. 4. Commercial fertilizers. By R. B. Warder.

*Bulletin No. 12, August 25, 1887, pp. 16. Experiments with wheat. By W. C. Latta.

Bulletins of the Purdue University Agricultural Experiment Station.

Bulletin No. 13, January, 1888, pp. 16. Report on new organization. By Pres. J. H. Smart.

Bulletin No. 14, April, 1888, pp. 20. Experiments with oats and corn. By W. C. Latta.

Bulletin No. 15, June, 1888, pp. 14, figs. 9. Concerning the potato tuber. By J. C. Arthur.

*Bulletin No. 16, August, 1888, pp. 12. Experiments with wheat. Crop rotation. By W. C. Latta.

Bulletin No. 17, November, 1888, pp. 4. Parturient apoplexy. By T. D. Hinebauch.

Bulletin No. 18, January, 1889, pp. 12, pl. I. Experiments with vegetables. By James Troop.

Bulletin No. 19, January, 1889, pp. 12, figs. 6. Spotting of peaches and cucumbers. By J. C. Arthur.

Bulletin No. 20, January, 1889, pp. 12, figs. 3, I. Experiments in cross fertilization. II. The culture of tropical ferns. By Pierre Van Landeghem.

Bulletin No. 21, February, 1889, pp. 16. How to feed rationally. By C. A. Wulff.

Bulletin No. 22, March, 1889, pp. 16. Commercial fertilizers. By H. A. Huston.

*Supply exhausted.

*Bulletin No. 23, April, 1889, pp. 12. Experiments with corn. By W. C. Latta.

*Bulletin No. 24, May, 1889, pp. 16, fig. 1, pl. I. Experiments on milk production. By C. A. Wulff.

Bulletin No. 25, June, 1889, pp. 18, fig. 3. Entomological experiments. By F. M. Webster.

Bulletin No. 26, July, 1889, pp. 20, figs. 9. Wheat rust. By H. L. Bolley.

*Bulletin No. 27, August, 1889, pp. 12. Field experiments with wheat. By W. C. Latta.

*Bulletin No. 28, September, 1889, pp. 24, figs. 7. Smut of wheat and oats. By J. C. Arthur.

*Bulletin No. 29, December, 1889, pp. 44, plates XIX. Grasses of Indiana. By James Troop.

*Bulletin No. 30, February, 1890, pp. 12, figs. 2. Influenza. By T. D. Hinebauch.

Bulletin No. 31, April, 1890, pp. 22, figs. 13. Experiments with small fruits and vegetables. By James Troop.

*Bulletin No. 32, July, 1890, pp. 22. (1) Treatment of smut in wheat, by J. C. Arthur. (2) Field experiments with wheat, by W. C. Latta. (3) A note on two inferior fertilizers, by C. S. Plumb.

*Bulletin No. 33, October, 1890, pp. 23-54, fig. 1. Small fruits, by James Troop. Entomological notes, by F. M. Webster. The absorptive power of soils, by H. A. Huston and Arthur Goss.

Bulletin No. 34, vol. II, February, 1891, pp. 55-80. (1) Sugar beets, by H. A. Huston. (2) Field experiments with commercial fertilizers and manure on barley and oats, by W. C. Latta. (3) Tests of vegetables, by James Troop.

*Bulletin N. 35, March, 1891, pp. 81-108, figs. 2-4. Loose smut of oats. By J. C. Arthur.

*Bulletin No. 36, vol. II, August, 1891, pp. 109-138. (1) Field experiments with wheat. (2) Testing grain, by W. C. Latta. (3) Wheat scab, by J. C. Arthur. (4) Forms of nitrogen for wheat, by H. A. Huston.

*Bulletin No. 37, Vol. II, December, 1891, pp. 139-150. (1) Steer feeding. A comparison of cut with uncut clover, by C. S. Plumb. (2) Composition and valuation of Indiana feeding stuffs, by H. A. Huston.

*Supply exhausted.

*Bulletin No. 38, vol. III, March, 1892, pp. 29, plate I. (1) Small fruits. (2) Treatment of powdery mildew and black rot. (3) Vegetables. By James Troop.

*Bulletin No. 39, vol. III, April, 1892, pp. 31-62, plates II, III. (1) Field experiments with corn, by W. C. Latta. (2) Sugar beets, by H. A. Huston. (3) Diseases of the sugar beet root, by J. C. Arthur.

Bulletin No. 40, vol. III, June, 1892, pp. 63-82, fig. 1. The silo and silage in Indiana. By C. S. Plumb.

Bulletin No. 41, vol. III, August, 1892, pp. 83-102. (1) Field experiments with wheat, by W. C. Latta. (2) Forms of nitrogen for wheat, by H. A. Huston.

*Bulletin No. 42, vol. III, November, 1892, pp. 103-118, figs. 4. The potato: The relation of number of eyes on the seed tuber to the product. By J. C. Arthur.

*Bulletin No. 43, vol. IV, March, 1893, pp. 20. (a) Field experiments with corn, by W. C. Latta. (b) The sugar beet in Indiana, by H. A. Huston.

*Bulletin No. 44, vol. IV, May, 1893, pp. 21-44, figs. 4. Dairy experiments. By C. S. Plumb.

*Bulletin No. 45, vol. IV. August, 1893, pp. 45-65. Field experiments with wheat, by W. C. Latta. Forms of nitrogen for wheat, by H. A. Huston.

Bulletin No. 46, vol. IV, September, 1893, pp. 66-85, fig. 1. (1, A modification of Grandeau's method for the determination of humus. (2) Preliminary ininvestigation relating to the determination of "crude fibre," by H. A. Huston and W. F. McBride.

*Bulletin No. 47, vol. IV, November, 1893, pp. 86-101, figs. 2. (1) Does it pay to shelter milch cows in winter? (2) Upon skim milk as a food for calves. By C. S. Plumb.

*Bulletin No. 48, vol. V, January, 1894, pp. 14. Experiments with small fruits. By James Troop.

*Bulletin No. 49, vol. V, March, 1894, pp. 15-40, figs. 3. Sugar beets. By H. A. Huston.

*Bulletin No. 50, vol. V, April, 1894, pp. 41-56. Field experiments with corn and oats. By W. C. Latta.

*Supply exhausted.

*Bulletin No. 51, August, 1894, pp. 57-80. (1) Field experiments with wheat, by W. C. Latta and Geo. R. Ives. (2) Forms of nitrogen for wheat, by H. A. Huston.

*Bulletin No. 52, vol. V, November, 1894, pp. 81-113, figs. 4, plates IV. Wild or prickly lettuce. By J. C. Arthur.

*Bulletin No. 53, vol. V, December, 1894, pp. 115-130, figs. 7, plates V, VI. Horticulture and entomology. By James Troop.

*Bulletin No. 54, vol. VI, February, 1895, pp. 8, plates II, fig. 1. New chemical apparatus. By H. A. Huston.

Bulletin No. 55, vol. VI, March, 1895, pp. 9-56, fig. 1. Experiments with small fruits, by James Troop. Experiments with corn and oats. By W. C. Latta and Geo. R. Ives.

Bulletin No. 56, vol. VI, August, 1895, pp. 57-80. Field experiments with wheat. By W. C. Latta and S. P. Carithers. Potaoto scab and its prevention. By J. C. Arthur.

*Bulletin No. 57, vol. VI. November, 1895, pp. 81-100, figs, 2-6, plates III-IV. The improvement unproductive black soil. By H. A. Huston.

*Bulletin No. 58, vol. VII, February, 1896, pp. 10. Hog cholera and swine plague in Indiana. By A. W. Bitting.

Bulletin No. 59, vol. VII, 1896, pp. 13-40, plates VIII, figs. 24. Bacteriosis of Carnations. By J. C. Arthur and H. L. Bolley.

*Bulletin No. 60, vol. VII, April, 1896, pp. 41-54, plates IX-XIV, figs. 25-31. The American persimmon. By James Troop and O. M. Hadley.

*Bulletin No. 61, vol. VII, August, 1896, pp. 55-70. Field experiments with wheat. By W. C. Latta and W. B. Anderson.

*Bulletin No. 62, vol. VII, October, 1896, pp. 71-96, figs. 32-42. The udder of the cow. By C. S. Plumb.

*Bulletin No. 63, vol. VII, December, 1896, pp. 97-116, plates XV-XVI. Bovine tuberculosis in Indiana. By A. W. Bitting.

Bulletin No. 64, vol. VIII, April, 1897, pp. 16. Field experiments with corn, oats and forage plants. By W. C. Latta and W. B. Anderson.

*Supply exhausted.

Bulletin No. 65, vol. VIII, June, 1897, pp. 17-36, plates II. Formalin for prevention of potato scab. By J. C. Arthur.

Bulletin No. 66, vol. VIII, October, 1897, pp. 37-60, plates III and IV, fig. 1. Indoor lettuce culture. By William Stuart. Condensed edition also, 8 pp.

*Bulletin No. 67, vol. VIII, December, 1897, pp. 61-70. Wheat and corn as food for pigs. C. S. Plumb and W. B. Anderson.

Bulletin No. 68, vol. IX, March, 1898, pp. 32, figs. 13. The sugar beet in Indiana. By H. A. Huston and J. M. Barrett.

Bulletin No. 69, vol. IX, March, 1898, pp. 33-40. Insecticides, fungicides and spraying. By James Troop.

Bulletin No. 70, vol. IX, 1898, pp. 41-52, figs. 14-16. The relation of water supply to animal diseases By A. W. Bitting.

Bulletin No. 71, vol. IX, June, 1898, pp. 53-64. I. Corn meal and shorts as food for pigs. By C. S. Plumb and W. B. Anderson. II. Skim-milk as food for young chickens. By W. B. Anderson.

Bulletin No. 72, vol. IX, August, 1898, pp. 65-76. Field experiments with wheat. B. W. C. Latta and W. B. Anderson.

Bulletin No. 73, vol. IX, October, 1898, pp. 77-92, figs. 17-19. Tests of strawberries, raspberries, blackberries grapes. By James Troop.

Bulletin No. 74, vol. IX, November, 1898, pp. 93-100, fig. 20, plates I-VI. A native white bedding plant. By J. C. Arthur.

Bulletin No. 75, vol. X, January, 1899, pp. 1-20, fig. 1. The sugar beet in Indiana in 1898. By H. A. Huston and A. H. Bryan.

*Bulletin No. 76, vol. X, March, 1899, pp. 21-28. Skim milk as a food for young growing chickens. By W. B. Anderson.

Bulletin No. 77, vol. X, March, 1899, pp. 29-44. Field experiments with corn. By W. C. Latta and W. B. Anderson.

Bulletin No. 78, vol. X, May, 1899, pp. 45-52. Figs 2-4. The San Jose and other scale insects, and the Indiana nursery inspection law. By James Troop.

*Supply exhausted.

Bulletin No. 79, vol. X, June, 1899, pp. 53-62. Roots as food for pigs. By C. S. Plumb and H. E. VanNorman.

Bulletin No. 80, vol. X, September, 1899, pp. 63-76, figs. 5-12. Sheep scab. By. A. W. Bitting.

Bulletin No. 81, vol. X, December, 1899, pp. 77-92. Field tests with fertilizers on heavy clay lands. By H. A. Huston.

Bulletin No. 82, vol. X, March, 1900, pp. 93-106. Roots and other succulent foods for swine. By C. S. Plumb.

Bulletin No. 83, vol. X, August, 1900, pp. 107-114. Test of small fruits. By James Troop.

Bulletin No. 84, vol. X, September, 1900, pp. 115-142, plates III, graphic charts III. Growing lettuce with chemical fertilizers. By William Stuart.

Bulletin No. 85, vol. X, October, 1900, pp. 143-150. Chrysanthemum rust. By J. C. Arthur.

Bulletin No. 86, vol. X, December, 1900, pp. 151-158. On the amount of water in slop fed fattening pigs. By C. S. Plumb and H. E. VanNorman.

Bulletin No. 87, Vol. XI, March, 1901, pp. 1-26. Formalin as a preventive of oats smut. By William Stuart.

Bulletin No. 88, Vol. XI, May, 1901, pp. 27-38. Systems of cropping with and without fertilization. By W. C. Latta and J. H. Skinner.

Bulletin No. 89, Vol. XI, July, 1901. pp. 39-69. The Production and Delivery of milk in cities. By A. W. Bitting.

Bulletin No. 90, Vol. XI, October, 1901, pp. 70-82. Tankage as a food for pigs. By C. S. Plumb and H. E. VanNorman .

Bulletin No.91, Vol. XI, January, 1902. pp. 83-106. Figs. 2-5. The Modern Silo. By C. S. Plumb.

Bulletin No. 92, Vol. XI. April, 1902, pp. 107-116. Fertilizer tests on tomatoes. By H. A. Huston.

Bulletin No. 93, Vol. XI, June, 1902, pp. 117-123. The influence of Condimental stock food in fattening swine. By C. S. Plumb.

Bulletin No. 94, Vol. XII, February, 1903, pp. 1-88. Illustrations 15. Diseases of Sheep. By A. W. Bitting and R. A. Craig.

*Supply exhausted.

Bulletin No. 95, Vol. XII, March, 1903, pp. 1-31, Plates I-IV, Figs. 1-5. The Improvement of Unproductive Black Soils. By H. A. Huston.

Bulletin No. 96, Vol. XII, July, 1903, pp. 1-36. Figs. 1-8. The Care of Milk and Butter Making on the Farm. By H. E. VanNorman.

Bulletin N. 97, Vol. XII, October, 1903, pp. 37-42. On the Value of distillery dried grains as a food for work horses. By C. S. Plumb.

Bulletin No. 98, Vol. XII. January, 1904, pp. 43-56. Fig. 1, plates I-VI. Three Edible Toadstools. By J. C. Arthur.

*Supply exhausted.

FINANCIAL STATEMENT.

Treasurer's Report.

Receipts from Experiment Station funds for the year ending June 30, 1903:

From United States Treasurer	$15,000.00
From Experiment Farm	1,713.42
Total	$16,713.42

JAMES M. FOWLER,
Treasurer Board of Trustees.

Secretary's Report.

The Agricultural Experiment Station of Indiana in account with the United States for the year ending June 30, 1903:

	Dr.	Cr.
Received from the United States Treasurer	$15,000.00	
Salaries		$ 7,253.48
Labor		3,410.81
Publications		757.13
Postage and Stationery		103.45
Freight and Express		90.92
Heat, Light, Water and Power		220.52
Chemical Supplies		3.59
Seeds, Plants and Sundry Supplies		565.31
Fertilizers		0.00
Feeding Stuffs		1,014.29
Library		117.97
Tools, Implements and Machinery		588.69
Furniture and Fixtures		0.00
Scientific Apparatus		428.85
Live Stock		11.00
Traveling Expenses		77.66
Contingent Expenses		6.62
Buildings and Repairs		349.71
Total	$15,000.00	$15,000.00

The above is a correct statement of expenditures from the Station Fund for the year ending June 30, 1903.

EDWARD A. ELLSWORTH,
Secretary Board of Trustees.

Improvement Fund, Experiment Farm for the year ending June 30, 1903:

	Dr.	Cr.
Balance June 30, 1902	$ 602.50	
Farm Receipts for 1903	1,713.42	
Salaries		$ 40.00
Labor		57.89
Chemical Supplies		76.85
Live Stock		48.00
Contingent Expenses		
(a) Telephones		30.00
(b) Insurance		144.00
(c) Membership A. A. A. C. & E. S.		15.00
Buildings and Repairs		1,072.85
Balance		831.33
Total	$2,315.92	$2,315.92

The above is a correct statement of expenditures from the improvement Fund for the year ending June 30, 1903.

EDWARD A. ELLSWORTH,
Secretary Board of Trustees.

These experiments have been started on the farms of the following named persons:

Muck Soil—L. C. Nice, Tippecanoe County, The American Farm Co., Newton County, and Sid Conger, Madison County.

Black Loam Soil.—Miss M. E. Hamlin, Benton county.

Clay Soil—David Pfendler, Marion county, E. E. Jones, Spencer county, A. A. Cravens, Washington county, and A. G. Mace, Scott county.

A series of tests with fertilizers and legume crops on some badly worn land on the farm of O. W. Caswell in Warrick county, were also started last spring. These tests are for the purpose of determining if it is possible at a reasonable expense and within a reasonable time to bring up a piece of badly worn land of very low fertility to a point where profitable crops can be produced. This test will necessarily occupy several years.

A number of requests have been received by the Station for this kind of work with which it has been impossible to comply, owing to lack of funds. It is hoped as soon as the necessary funds are secured to extend this work to other sections of the state.

2. A study of the corn plant with a view to determining the following points:

(a) The effect of the use of different fertilizing ingredients on the development, yield and composition.

(b) A study of the effect of fertilization under proper moisture conditions as compared with ordinary practice.

(c) The chemical composition of the corn plant grown under proper moisture conditions and under ordinary practice.

(d) The assimilation of plant food under proper moisture conditions and ordinary practice.

(e) The effect of fertilization on the composition under proper moisture conditions as compared with ordinary practice.

3. A continuation of the experiment in cooperation with the Bureau of Chemistry, U. S. Department of Agriculture, upon "The influence of soil and climate on the composition of the sugar beet."

4. A study concerning the influence of fertilization on the development, yield and composition of the sugar beet.

5. An investigation concerning the influence of the composition of the water in and under muck soils, on the growth of crops.

6. The investigation in regard to the solubility of phosphatic fertilizers from different sources in various reagents under different conditions of time, temperature, quantity, volume, acidity and alkalinity of digesting solutions, was continued.

7. The investigation in cooperation with the Agricultural department in corn breeding, was continued.

8. An investigation was made in cooperation with the Dairy department concerning the moisture content of butter under different conditions of manufacture.

9. Analyses of various samples of cattle foods were made during the year for the Animal Husbandry department.

10. Examination of the stomachs of cattle which had died under suspicious circumstances were made for the Veterinary department.

11. Considerable time was devoted to soil investigations in cooperation with the Referee on Soils for the Association of Official Agricultural Chemists.

12. A number of miscellaneous analyses of samples of clay, wood ashes, wheat, tobacco stems and other materials were made during the year. ARTHUR GOSS, Chemist.

Report of the Veterinary Department.

ARTHUR GOSS, Director.

Sir:—The Veterinary Department completed a manuscript upon "Diseases of Swine," in October, 1903. This work is a brief monograph upon the more common diseases of swine. It incorporated the results of a large amount of work done along that line since 1903. Dr. R. A. Craig, Assistant State Veterinarian, has contributed a large part, as part of the work of the Office of State Veterinarian. The manuscript has been freed of technicalities as far as possible, and the aim has been to make the results valuable to swine breeders.

I believe this to be the most important matter the Department has submitted for publication. Its being withheld because of insufficiency of funds is unfortunate at this time, when there is so much disease and loss to combat.

The Department has other lines of work under way, the results of which may be made available within the year.

No change has been made in the physical equipment.

Respectfully submitted,

A. W. BITTING, Veterinarian.

Report of the Animal Husbandry Department.

ARTHUR GOSS, Director.

Sir:—The following report for the year ending June 30, 1904, is respectfully submitted:

During the year, feeding experiments have been conducted to determine something of the value of soy beans as a source of protein for growing and fattening swine. The average Indiana farm has

abundance of corn to feed. This grain, while an excellent feed for swine, is deficient in protein and mineral matter, a fact which makes it necessary for the farmer who would handle his hogs most successfully, to grow or purchase some feed to supplement the corn. The main source of such feed supply has been the bi-products of the flouring mill, such as shorts, middlings and bran. These feeds have become high priced and hard to get in many local markets in Indiana. Consequently, the importance of finding some new source from which the pig feeder can secure a supplement to the corn ration. Already valuable data has been secured in regard to feeding the grain of the soy bean. With the soy bean, the Department has compared corn, tankage and shorts. Different methods of feeding the beans have been studied.

Bacon Hogs.—This subject has been under investigation during the year. Methods of breeding and crossing bacon and lard hogs, as well as the amount, cost and quality of pork produced, have been carefully studied, with the view of securing desirable information, which in the light of present inquiries from pork producers is much needed.

This branch of the work, the swine, makes good returns for the money invested, besides furnishing a good field for investigation along practical lines, which are of vital importance to American, and especially Indiana farmers.

The Farm.—On July 10, the main cattle barn was struck by lightning, and with its contents destroyed. This included hay and a small quantity of grain and mill feed, mills, electric motor and various tools and equipment ordinarily found in such a barn. Since then a new feeding barn has been erected at a cost of $2,000. This building is a plank frame structure, sided with drop siding, shingle roof, concrete floors and stave silo. It was planned primarily for a beef cattle feeding barn with sheds and open yard in connection, but at present accommodates the dairy and breeding herd of beef cattle.

The buildings on the farm have been repaired and are now in good condition, except the sheep barn. The horse barn has been painted and the fences and drives renewed and repaired, so that I can say that the farm buildings, fences and drives are in good repair; far better than a year ago.

The grain and forage crops grown during the year, have been largely consumed by the live stock. Excellent returns have been obtained from all land under cultivation, and the dairy herd has made a satisfactory return for the food consumed. The loss of about 45 tons of hay, which under local conditions, ran the farm feed bill excessively high.

Respectfully submitted,

J. H. Skinner,

Head of Animal Husbandry Department.

Report of the Dairy Department.

ARTHUR GOSS, Director.

Sir:—During the current year considerable attention has been given to the subject of the moisture content of butter and methods of controlling it on a commercial scale, but our work has not as yet resulted in any conclusive results. The question of methods of handling hand separator cream is still under investigation. We are receiving a regular supply of this class of cream, which is slowly increasing, making it possible to carry on this work to better advantage.

Lack of facilities has prevented much progress in the work of pasteurization, though records are being kept of much of the routine work, giving useful data for reference.

A modification of the methods usually employed for the determination of the acidity of cream has been worked out and used in the regular work of the department for the past year, giving such satisfaction that a report of the same has been prepared for publication.

A considerable number of samples of milk and skim milk have been tested from time to time, and a number of samples of butter have been scored for different creameries in the state, suggestions and criticisms together with the score having been returned to the makers.

I recommend the securing of funds which will enable the Department to carry on in a systematic way investigation work among the creameries and dairy farms of the state, to the end that losses now incurred may be lessened, better methods employed and an improved quality of dairy products placed on the market, and further the work already in progress in the laboratories.

Respectfully submitted,
H. E. VANNORMAN,
Head of Dairy Department.

Periodicals.

The following periodicals are on file in the Station Library as regular subscription journals:—

Berichte der Deutschen-Botanischen Gesselschaft............ .... Berlin, Germany.
Botanisches Centralblatt...............Cassel-Marburg, Germany.
Botanische Zeitung..........................Leipsig, Germany.
Bulletin de la Societe Chemique de Paris............Paris, France.
Centrallblatt fur Bakteriologie..................Jena, Germany.
Chemiker Zeitung............................ Cothen, Germany
The Entomologist............................London, England.
Gardeners' Chronicle ....London, England.
Journal of Botany..........................London, England.
Journal fur Landwirthschaft...................Berlin, Germany.
Journal of Comparative Medicine and Veterinary Archives.... .... Philadelphia, Pa.
Journal of the Royal Agricultural Society of England...... .... London, England.
Journal of the Chemical Society...............London, England.
Landwirthschaftlichen Versuchs-Stationen.......Berlin, Germany.
Live Stock Journal........................ London, England.
Review Mycologie...........................London, England.
Veterinarian ....London, England.
Veterinary Journal..........................London, England.
Zeitschrift fur Analytische Chemie..........Weisbaden, Germany.

Periodicals Donated.

The publishers of the following periodicals have generously sent them free to the Station during the year. These are leading journals and are frequently used by all persons coming in contact with our library.

Agricultural Periodicals.

Agricultural Advertising - - -	Chicago, Ill.
Agricultural Experiments - - -	Minneapolis, Minn.
American Agriculturist - - -	New York, N. Y.
American Fertilizer - - - -	Philadelphia, Pa.
American Grange Bulletin - - -	Cincinnati, Ohio.
American Horticulturist - - -	Wichita, Kansas.
American Swineherd - - - -	Chicago, Ill.
Baltimore Sun (Daily) - - -	Baltimore, Md.
Beet Sugar Gazette - - - -	Chicago, Ill.

Blooded Stock - - - - -	Oxford, Pa.
Breeders' Gazette - - - -	Chicago, Ill.
California Cultivator - - - -	Los Angeles, Cal.
Campbell's Soil Culture - - -	Lincoln, Neb.
Chicago Dairy Produce - - -	Chicago, Ill.
Chicago Live Stock World - - -	Chicago, Ill.
Colman's Rural World - - -	St. Louis, Mo.
Commercial Poultry - - - -	Chicago, Ill.
Creamery Gazette - - - -	Des Moines, Ia.
Creamery Journal - - - -	Waterloo, Iowa.
Dairy and Creamery - - - -	Chicago, Ill.
Dairy and Produce Review - - -	San Francisco, Cal.
Dairy Record - - - - -	St. Paul, Minn.
Dakota Farmer - - - - -	Fargo, N. D.
Dakota Field and Farm - - -	Sioux Falls, S. D.
Deutsch Amerikanischer Farmer - -	Lincoln, Neb.
Drainage Journal - - - -	Indianapolis, Ind.
Drovers' Journal - - - - -	Chicago, Ill.
Elgin Dairy Report - - - -	Elgin, Ill.
Experiment Station Record - - -	Washington, D. C.
Farm and Fireside - - - -	Springfield, Ohio.
Farm and Live Stock Journal - -	Detroit, Mich.
Farm, Field and Fireside - - -	Chicago, Ill.
Farm and Home - - - - -	Chicago, Ill.
Farm, Stock and Home - - -	Minneapolis, Minn.
Farm Journal - - - - -	Philadelphia, Pa.
Farm Poultry - - - - -	Boston, Mass.
Farm Star - - - - - -	Indianapolis, Ind.
Farm Stock Journal - - - -	Rochester, N. Y.
Farmers' Call - - - - -	Quincy, Ill.
Farmers' Guide - - - - -	Huntington, Ind.
Farmers' Home - - - - -	Dayton, Ohio.
Farmers' Review - - - - -	Chicago, Ill.
Farmers' Sentinel - - - -	Milwaukee, Wis.
Farmers' Tribune - - - -	Sioux City, Iowa.
Farmers' Voice - - - - -	Chicago, Ill.
The Feather - - - - -	Washington, D. C.
Field and Farm - - - - -	Denver, Colo.
Flour and Feed - - - - -	Milwaukee, Wis.
Hoard's Dairyman - - - -	Ft. Atkinson, Wis.
Home and Farm - - - - -	Louisville. Ky.
Hospodarska Listy - - - -	Chicago, Ill.
Indiana Farmer - - - - -	Indianapolis, Ind.
Iowa Homestead - - - -	Des Moines, Iowa.

Journal of Agriculture - - -	St. Louis, Mo.
Kansas Farmer - - - - - -	Topeka, Kan.
Kimball's Dairy Farmer - - -	Waterloo, Iowa.
Live Stock and Dairy Journal - -	Fresno, Cal.
Live Stock Journal - - - -	Chicago, Ill.
Live Stock Journal - - - - -	Indianapolis, Ind.
Louisiana Planter - - - -	New Orleans, La.
Mennonitische Rundschau - - -	Elkhart, Ind.
Metropolitan Rural Home - - -	New York, N. Y.
Modern Farmer - - - - -	St. Joseph, Mo.
National Stockman and Farmer - -	Pittsburg, Pa.
Nebraska Farmer - - - - - -	Lincoln, Neb.
New England Farmer - - -	Boston, Mass.
New York Produce Review - - -	New York, N. Y.
New York Tribune Farmer - -	New York, N. Y.
Northwestern Agriculturist - - -	Minneapolis, Minn.
Northwest Horticulturist - - -	Tacoma, Wash.
Ohio Farmer - - - - - -	Cleveland, Ohio.
Orange Judd Farmer - - -	Chicago, Ill.
Operative Miller - - - - - -	Chicago, Ill.
Oregon Agriculturist - - - -	Portland, Oregon.
Our Horticultural Visitor - - -	Benton Harbor, Mich.
Pacific Rural Press - - - -	San Francisco, Cal.
Practical Farmer - - - - - -	Philadelphia, Pa.
Prairie Farmer - - - - - -	Chicago, Ill.
Reliable Poultry Journal - - -	Quincy, Ill.
St. Louis Republic - - - - -	St. Louis, Mo.
Southern Farm Magazine - - -	Baltimore, Md.
Southern Planter - - - - -	Richmond, Va.
Southern States - - - - - -	Baltimore, Md.
Strawberry Specialist - - - -	Kittrell, N. C.
Successful Farming - - - -	Des Moines, Iowa.
Sugar Beet - - - - - -	Philadelphia, Pa.
Swine Breeders' Journal - - -	Indianapolis, Ind.
Trade, The - - - - - -	Baltimore, Md.
Tri-State Farmer - - - -	Chattanooga, Tenn.
Up-To-Date Farming - - -	Indianapolis, Ind.
Wallace's Farmer - - - -	Des Moines, Ia.
Western Horseman - - - - -	Indianapolis, Ind.
West Virginia Farm Review - -	Charlestown, W. Va.
Wisconsin Agriculturist - - -	Racine, Wis.
Wool Markets and Sheep - -	Chicago, Ill.

GENERAL STATE PERIODICALS.

Advertiser - - - - - -	Medaryville, Ind.
American Standard - - - -	Frankfort, Ind.
Banner - - - - - -	Bluffton, Ind.
Columbia City Mail - - - -	Columbia City, Ind.
Democrat - - - - - -	Salem, Ind.
Enterprise - - - - - -	Wolcott, Ind.
Home Journal - - - - -	LaFayette, Ind.
Hoosier State - - - - -	Newport, Ind.
LaFayette Commercial Gazette - -	LaFayette, Ind.
Lyons Herald - - - - -	Lyons, Ind.
News - - - - - -	Monon, Ind.
Public Press - - - - -	New Albany, Ind.
Recorder - - - - - -	Rising Sun, Ind.
Register - - - - - -	Crown Point, Ind.
Ripley Journal - - - - -	Osgood, Ind.
Silent Hoosier - - - - -	Indianapolis, Ind.

FOREIGN PERIODICALS.

Agricultur'l Gazette of New South Wales	Sidney, Australia.
Agricultural Journal and Mining Record	Natal, S. A.
Cooperative Farming - - - -	Sussex, N. B.
Farmers' Advocate - - - -	London, Ontario.
Journal of the Royal Horticultural Society - - - - - - -	London, England.
Station, Farm and Dairy - - -	Sidney, N. S. W.
Transvaal Agricultural Journal - -	Pretoria, S. A.
Queensland Agricultural Journal -	Brisbane, Australia.

Donations.

Besides the list of Periodicals already mentioned the Station acknowledges with thanks the receipt of the following donations during the year:

FERTILIZERS FOR COOPERATIVE FIELD TESTS.

The German Kali Works, New York,
One ton Kainit.
1,000 pounds Muriate of Potash.
1,000 pounds Sulphate of Potash.

Armour & Company, Chicago.
Two tons Dried Blood.

E. Rauh & Sons, Indianapolis.
One ton Acid Phosphate.
1,000 pounds Dried Blood.

Read Phosphate Co., Nashville, Tenn.
Two tons Ground Rock Phosphate.

SEED CORN FOR COOPERATIVE VARIETY TESTS.

W. A. Alexander, L. B. Clore, J. P. Davis, E. F. Diehl, F. P. Hoopengardner, A. G. Mace, J. R. Overstreet, Marley Riley, H. M. Stout, A. E. Thompson, L. M. Vogler, and J. D. Whitesides.

INSECTICIDES FOR SPRAYING TESTS.

James Good, Philadelphia, Pa.
100 pounds Caustic Potash Whale Oil Soap.

LIST OF BULLETINS

Published by

The Indiana Agricultural Experiment Station,

To December 1, 1904.

Bulletins of the School of Agriculture.

*Bulletin No. 1, January, 1885, pp. 10, pl. II. The Hessian fly. By F. M. Webster.

*Bulletin No. 2, January, 1885, pp. 12. Experiments with nitrogenous, phosphatic and other fertilizers. By W. C. Latta.

*Bulletin No. 3, April, 1885, pp. 8, pl. III. Insects affecting growing wheat. By F. M. Webster.

*Bulletin No. 4, September, 1885, pp. 12. Experiments with wheat. By W. C. Latta.

*Bulletin No. 5, November, 1885, pp. 12, pl. II. Experiments with small fruits. By James Troop.

*Bulletin No. 6, March, 1886, pp. 16. Experiments with oats and corn. By W. C. Latta.

*Bulletin No. 7, 1886, pp. 12. Commercial fertilizers and notes on agricultural chemistry. By R. B. Warder.

*Bulletin No. 8, August 24, 1886, pp. 16. Experiments with wheat. By W. C. Latta.

*Bulletin No. 9, October 30, 1886, pp. 8, pl. I. The American Meromyza. By F. M. Webster.

*Bulletin No. 10, December 15, 1886, pp. 8. Report of the Director of the Indiana State Horticultural Experiment Stations. By James Troop.

*Bulletin No. 11, 1887, pp. 4. Commercial fertilizers. By R. B. Warder.

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*Supply Exhausted.

*Bulletin No. 12, August 25, 1887, pp. 16. Experiments with wheat. By W. C. Latta.

Bulletins of the Purdue University Agricultural Experiment Station.

Bulletin No. 13, January, 1888, pp. 16. Report on new organization. By Pres. J. H. Smart.

Bulletin No. 14, April, 1888, pp. 20. Experiments with oats and corn. By W. C. Latta.

Bulletin No. 15, June, 1888, pp. 14, figs. 9. Concerning the potato tuber. By J. C. Arthur.

*Bulletin No. 16, August, 1888, pp. 12. Experiments with wheat. Crop rotation. By W. C. Latta.

Bulletin No. 17, November, 1888, pp. 4. Parturient apoplexy. By T. D. Hinebauch.

Bulletin No. 18, January, 1889, pp. 12, pl. I. Experiments with vegetables. By James Troop.

Bulletin No. 19, January, 1889, pp. 12, figs. 6. Spotting of peaches and cucumbers. By J. C. Arthur.

Bulletin No. 20, January, 1889, pp. 12, figs. 3, I. Experiments in cross fertilization. II. The culture of tropical ferns. By Pierre Van Landeghem.

Bulletin No. 21, February, 1889, pp. 16. How to feed rationally. By C. A. Wulff.

Bulletin No. 22, March, 1889, pp. 16. Commercial fertilizers. By H. A. Huston.

*Bulletin No. 23, April, 1889, pp. 12. Experiments with corn. By W. C. Latta.

*Bulletin No. 24, May, 1889, pp. 16, fig. 1, pl. I. Experiments on milk production. By C. A. Wulff.

Bulletin No 25, June, 1889, pp. 18, figs. 3. Entomological experiments. By F. M. Webster.

Bulletin No. 26, July, 1889, pp. 20, figs. 9. Wheat rust. By H. L. Bolley.

*Bulletin No. 27, August, 1889, pp. 12. Field experiments with wheat. By W. C. Latta.

*Bulletin No. 28, September, 1889, pp. 24, figs. 7. Smut of wheat and oats. By J. C. Arthur.

*Bulletin No. 29, December, 1889, pp. 44, plates XIX. Grasses of Indiana. By James Troop.

*Bulletin No. 30, February, 1890, pp. 12, figs. 2. Influenza. By T. D. Hinebauch.

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*Supply Exhausted.

Bulletin No. 31, April, 1890, pp. 22, figs. 13. Experiments with small fruits and vegetables. By James Troop.

*Bulletin No. 32, July, 1890, pp. 22. (1) Treatment of smut in wheat, by J. C. Arthur. (2) Field experiments with wheat, by W. C. Latta. (3) A note on two inferior fertilizers, by C. S. Plumb.

*Bulletin No. 33, October, 1890, pp. 23-54, fig. 1. Small fruits, by James Troop. Entomological notes, by F. M. Webster. The absorptive power of soils, by H. A. Huston and Arthur Goss.

Bulletin No. 34, vol. II, February, 1891, pp. 55-80. (1) Sugar beets, by H. A. Huston. (2) Field experiments with commercial fertilizers and manure on barley and oats, by W. C. Latta. (3) Tests of vegetables, by James Troop.

*Bulletin No. 35, March, 1891, pp. 81-108, figs. 2-4. Loose smut of oats. By J. C. Arthur.

*Bulletin No. 36, vol. II, August, 1891, pp. 109-138. (1) Field experiments with wheat. (2) Testing grain, by W. C. Latta. (3) Wheat scab, by J. C. Arthur. (4) Forms of nitrogen for wheat, by H. A. Huston.

*Bulletin No. 37, vol. II, December, 1891, pp. 139-150, (1) Steer feeding. A comparison of cut with uncut clover, by C. S. Plumb. (2) Composition and valuation of Indiana feeding stuffs, by H. A. Huston.

*Bulletin No. 38, vol. III, March, 1892, pp. 29, plate I. (1) Small fruits. (2) Treatment of powdery mildew and black rot. (3) Vegetables. By James Troop.

*Bulletin No. 39, vol. III, April, 1892, pp. 31-62, plates II, III. (1) Field experiments with corn, by W. C. Latta. (2) Sugar beets, by H. A. Huston. (3) Diseases of the sugar beet root, by J. C. Arthur.

Bulletin No. 40, vol. III, June, 1892, pp. 63-82, fig. 1. The silo and silage in Indiana. By C. S. Plumb.

Bulletin No. 41, vol. III, August, 1892, pp. 83-102. (1) Field experiments with wheat, by W. C. Latta. (2) Forms of nitrogen for wheat, by H. A. Huston.

*Bulletin No. 42, vol. III, November, 1892, pp. 103-118, figs. 4. The potato: The relation of number of eyes on the seed tuber to the product. By J. C. Arthur.

***Supply Exhausted.**

*Bulletin No. 43, vol. IV, March, 1893, pp. 20. (a) Field experiments with corn, by W. C. Latta. (b) The sugar beet in Indiana, by H. A. Huston.

*Bulletin No. 44, vol. IV, May, 1893, pp. 21-44, figs. 4. Dairy experiments. By C. S. Plumb.

*Bulletin No. 45, vol. IV, August, 1893, pp. 45-65. Field experiments with wheat, by W. C. Latta. Forms of nitrogen for wheat, by H. A. Huston.

Bulletin No. 46, vol. IV, September, 1893, pp. 66-85, fig. 1. (1) A modification of Grandeau's method for the determination of humus. (2) Preliminary investigation relating to the determination of "crude fibre," by H. A. Huston and W. F. McBride.

*Bulletin No. 47, vol. IV, November, 1893, pp. 86-101, figs. 2. (1) Does it pay to shelter milch cows in winter? (2) Upon skim milk as a food for calves. By C. S. Plumb.

*Bulletin No. 48, vol. V, January, 1894, pp. 14. Experiments with small fruits. By James Troop.

*Bulletin No. 49, vol. V, March, 1894, pp. 15-40, figs. 3. Sugar beets. By H. A. Huston.

*Bulletin No. 50, vol. V, April, 1894, pp. 41-56. Field experiments with corn and oats. By W. C. Latta.

*Bulletin No. 51, August, 1894, pp. 57-80. (1) Field experiments with wheat, by W. C. Latta and Geo. R. Ives. (2) Forms of nitrogen for wheat, by H. A. Huston.

*Bulletin No. 52, vol. V, November, 1894, pp. 81-113, figs. 4, plates IV. Wild or prickly lettuce. By J. C. Arthur.

*Bulletin No. 53, vol. V, December, 1894, pp. 115-130, figs. 7, plates V, VI. Horticulture and entomology. By James Troop.

*Bulletin No. 54, vol. VI, February, 1895, pp. 8, plates II, fig. 1. New chemical apparatus. By H. A. Huston.

Bulletin No. 55, vol. VI, March, 1895, pp. 9-56, fig. 1. Experiments with small fruits, by James Troop. Experiments with corn and oats. By W. C. Latta and George R. Ives.

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*Supply Exhausted.

Bulletin No. 56, vol. VI, August, 1895, pp. 57-80. Field experiments with wheat. By W. C. Latta and S. P. Carithers. Potato scab and its prevention. By J. C. Arthur.

*Bulletin No. 57, vol. VI. November, 1895, pp. 81-100, figs, 2-6, plates III-IV. The improvement of unproductive black soil. By H. A. Huston.

*Bulletin No. 58, vol. VII, February, 1896, pp. 10. Hog cholera and swine plague in Indiana. By A. W. Bitting.

Bulletin No. 59, vol. VII, 1896, pp. 13-40, plates VIII, figs. 24. Bacteriosis of Carnations. By J. C. Arthur and H. L. Bolley.

*Bulletin No. 60, vol. VII, April, 1896, pp. 41-54, plates IX-XIV, figs. 25-31. The American persimmon. By James Troop and O. M. Hadley.

*Bulletin No. 61, vol. VII, August, 1896, pp. 55-70. Field experments with wheat. By W. C. Latta and W. B. Anderson.

*Bulletin No. 62, vol. VII, October, 1896, pp. 71-96, figs. 32-42. The udder of the cow. By C. S. Plumb.

*Bulletin No. 63, vol. VII, December, 1896, pp. 97-116, plates XV-XVI. Bovine tuberculosis in Indiana. By A. W. Bitting.

Bulletin No. 64, vol. VIII, April, 1897, pp. 16. Field experiments with corn, oats and forage plants. By W. C. Latta and W. B. Anderson.

Bulletin No. 65, vol. VIII, June, 1897, pp. 17-36, plates II. Formalin for prevention of potato scab. By J. C. Arthur.

Bulletin No. 66, vol. VIII, October, 1897, pp. 37-60, plates III and IV, fig. 1. Indoor lettuce culture. By William Stuart. Condensed edition also, 8 pp.

*Bulletin No. 67, vol. VIII, December, 1897, pp. 61-70. Wheat and corn as food for pigs. C. S. Plumb and W. B. Anderson.

Bulletin No. 68, vol. IX, March, 1898, pp. 32, figs. 13. The sugar beet in Indiana. By H. A. Huston and J. M. Barrett.

Bulletin No. 69, vol. IX, March, 1898, pp. 33-40. Insecticides, fungicides and spraying. By James Troop.

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*Supply Exhausted.

Bulletin No. 70, vol. IX, 1898, pp. 41-52, figs. 14-16. The relation of water supply to animal diseases. By A. W. Bitting.

Bulletin No. 71, vol. IX, June, 1898, pp. 53-64. I. Corn meal and shorts as food for pigs. By C. S. Plumb and W. B. Anderson. II. Skim-milk as food for young chickens. By W. B. Anderson.

Bulletin No. 72, vol. IX, August, 1898, pp. 65-76. Field experiments with wheat. By W. C. Latta and W. B. Anderson.

Bulletin No 73, vol. IX, October, 1898, pp. 77-92, figs. 17-19. Tests of strawberries, raspberries, blackberries, grapes. By James Troop.

Bulletin No. 74, vol. IX, November, 1898, pp. 93-100, figs. 20, plates I-VI. A native white bedding plant. By J. C. Arthur.

Bulletin No. 75, vol. X, January, 1899, pp. 1-20, fig. 1. The sugar beet in Indiana in 1898. By H. A. Huston and A. H. Bryan.

*Bulletin No. 76, vol. X, March, 1899, pp. 21-28. Skim milk as a food for young growing chickens. By W. B. Anderson.

Bulletin No. 77, vol. X, March, 1899, pp. 29-44. Field experiments with corn. By W. C. Latta and W. B. Anderson.

Bulletin No. 78, vol. X, May, 1899, pp. 45-52. Figs. 2-4. The San Jose and other scale insects, and the Indiana nursery inspection law. By James Troop.

Bulletin No. 79, vol. X, June, 1899, pp. 53-62. Roots as food for pigs. By C. S. Plumb and H. E. Van Norman.

Bulletin No. 80, vol. X, September, 1899, pp. 63-76, figs. 5-12. Sheep scab. By A. W. Bitting.

Bulletin No 81, vol. X, December, 1899, pp. 77-92. Field tests with fertilizers on heavy clay lands. By H. A. Huston.

Bulletin No. 82, vol. X, March, 1900, pp. 93-106. Roots and other succulent foods for swine. By C. S. Plumb.

Bulletin No. 83, vol. X, August, 1900, pp. 107-114. Test of small fruits. By James Troop.

Bulletin No. 84, vol. X, September, 1900, pp. 115-142, plates III, graphic charts III. Growing lettuce with chemical fertilizers. By William Stuart.

***Supply Exhausted.**

Bulletin No. 85, vol. X, October, 1900, pp. 143-150. Chrysanthemum rust. By J. C. Arthur.

Bulletin No. 86, vol. X, December, 1900, pp. 151-158. On the amount of water in slop fed fattening pigs. By C. S. Plumb and H. E. Van Norman.

Bulletin No. 87, vol. XI, March, 1901, pp. 1-26. Formalin as a preventive of oats smut. By William Stuart.

Bulletin No. 88, vol. XI, May, 1901, pp. 27-38. Systems of cropping with and without fertilization. By W. C. Latta and J. H. Skinner.

Bulletin No. 89, vol. XI, July, 1901, pp. 39-69. The production and delivery of milk in cities. By. A. W. Bitting.

Bulletin No. 90, vol. XI, October, 1901, pp. 70-82. Tankage as a food for pigs. By C. S. Plumb and H. E. Van Norman.

Bulletin No. 91, vol. XI, January, 1902, pp. 83-106. Figs. 2-5. The modern silo. By C. S. Plumb.

Bulletin No. 92, vol. XI. April, 1902, pp. 101-116. Fertilizer tests on tomatoes. By H. A. Huston.

Bulletin No. 93, vol. XI, June, 1902, pp. 117-123. The influence of Condimental stock food in fattening swine. By C. S. Plumb.

Bulletin No. 94, vol. XII, February, 1903, pp. 1-88. Illustrations 15. Diseases of sheep. By A. W. Bitting and R. A. Craig.

Bulletin No. 95, vol. XII, March, 1903, pp. 1-31, Plates I-IV, Figs. 1-5. The improvement of unproductive black soils. By H. A. Huston.

Bulletin No 96, vol. XII, July, 1903, pp. 1-36. Figs. 1-8. The care of milk and butter making on the farm. By H. E. VanNorman.

Bulletin No. 97, vol. XII, October, 1903, pp. 37-42. On the value of distillery dried grains as a food for work horses. By C. S. Plumb.

Builetin No. 98, vol. XII. January, 1904, pp. 43-56. Fig. 1, plates I-VI. Three edible toadstools. By J. C. Arthur.

Bulletin No. 99, vol. XII, March, 1904, pp. 57-68. Tests of small fruits. By James Troop.

Bulletin No. 100, vol XII, September, 1904, pp. 69-204. Illustrations 23. Diseases of swine. By R. A. Craig and A. W. Bitting.

FINANCIAL STATEMENT.

Treasurer's Report.

Receipts from Experiment Station funds for the year ending June 30, 1904:

Balance from improvement fund June 30, 1903 - -	$ 831 33
From United States Treasurer - - - - -	15,000 00
From Experiment Farm - - - - - - - -	1,585 39
Total - - - - - - - - - -	$17,416 72

JAMES M. FOWLER,
Treasurer Board of Trustees.

Secretary's Report.

The Agricultural Experiment Station of Indiana in account with the United States for the year ending June 30, 1904:

	Dr.	Cr.
Received from the United States Treasurer	$15,000 00	
Salaries - - - - - - - -		$ 7,779 50
Labor - - - - - - - - -		3,504 79
Publications - - - - - - -		769 32
Postage and Stationery - - - - -		107 58
Freight and Express - - - - -		115 61
Heat, Light, Water and Power - -		249 71
Chemical Supplies - - - - -		6 30
Seeds, Plants and Sundry Supplies - -		535 09
Fertilizers - - - - - - - -		1 00
Feeding Stuffs - - - - - -		1,290 65
Library - - - - - - - -		93 46
Tools, Implements and Machinery - -		126 52
Furniture and Fixtures - - - -		8 00
Scientific Apparatus - - - - -		0 00
Live Stock - - - - - - - -		37 00
Traveling Expenses - - - - -		191 06
Contingent Expenses - - - - -		19 90
Buildings and Repairs - - - - -		164 51
Total - - - - - - -	$15,000 00	$15,000 00

The above is a correct statement of expenditures from the Station Fund for the year ending June 30, 1904.

EDWARD A. ELLSWORTH,
Secretary Board of Trustees.

Improvement Fund, Experiment Farm for the year ending June 30, 1904:

	Dr.	Cr.
Balance June 30, 1903	$ 831 33	
Farm Receipts for 1904	1,585 39	
Salaries		$ 32 06
Labor		254 75
Publications		24 50
Postage and Stationery		19 25
Freight and Express		10 27
Heat, Light, Water and Power		11 66
Chemical Supplies		25 24
Seeds, Plants and Sundry Supplies		42 60
Fertilizers		0 00
Feeding Stuffs		515 10
Library		101 05
Tools, Implements and Machinery		61 75
Furniture and Fixtures		0 00
Scientific Apparatus		0 00
Live Stock		18 91
Traveling Expenses		1 20
Contingent Expenses		62 00
Buildings and Repairs		183 65
*Balance		1,052 73
Total	$ 2,416 72	$ 2,416 72

The above is a correct statement of expenditures from the Improvement Fund for the year ending June 30, 1904.

EDWARD A. ELLSWORTH,
Secretary Board of Trustees.

*Covered by outstanding liabilities.

Summary of Total Receipts and Expenditures of the Station for the Year Ending June 30, 1904.

	Dr.	Cr.
Balance from year previous - - - -	$ 831 33	
Received from U. S. Gov. Hatch Fund	15,000 00	
Receipts from sale of Farm products, etc.	1,585 39	
Salaries - - - - - - -		$ 7,811 56
Labor - - - - - - - - -		3,759 54
Publications - - - - - -		793 82
Postage and Stationery - - - - -		126 83
Freight and Express - - - - -		125 88
Heat, Light, Water and Power - -		261 37
Chemical Supplies - - - - -		31 54
Seeds, Plants, and Sundry Supplies -		577 69
Fertilizers - - - - - - -		1 00
Feeding stuffs - - - - - -		1,805 75
Library - - - - - - - -		194 51
Tools, Implements and Machinery -		188 27
Furniture and Fixtures - - - - -		8 00
Scientific Apparatus - - - - -		0 00
Live Stock - - - - - - - -		55 91
Traveling Expenses - - - - -		192 26
Contingent Expenses - - - - -		81 90
Buildings and Repairs - - - -		348 16
*Balance Carried Over - - - - -		1,052 73
Total - - - - - - -	$17,416 72	$17,416 72

*Covered by outstanding liabilities.

PURDUE UNIVERSITY

Eighteenth Annual Report

OF THE

Agricultural Experiment Station

LAFAYETTE, INDIANA

For the Year Ending June 30, 1905

LAFAYETTE, IND.
PRESS OF BURT-TERRY-WILSON CO.
1906

PURDUE UNIVERSITY

Eighteenth Annual Report

OF THE

Agricultural Experiment Station

LAFAYETTE, INDIANA

For the Year Ending June 30, 1905

LAFAYETTE, IND.
PRESS OF BURT-TERRY-WILSON CO.
1906

To the Governor:

I transmit herewith the annual report of the Purdue University Agricultural Experiment Station for the year ending June 30, 1905.

WILLIAM V. STUART,

President of the Board of Trustees.

December 1, 1905.

To the President of the Board of Trustees:

I herewith present the eighteenth annual report of the Agricultural Experiment Station of Indiana for the year ending June 30, 1905, the same being required by Section 3, of an act entitled "An act to establish Agricultural Experiment Stations in connection with the Colleges established in the several States, under provisions of an act approved July, 1862, and of the acts supplemental thereto," and being in accordance also with the instructions of the Department of Agriculture.

This report consists of a report of the Director of the Station, a summary of Station investigations by members of the Staff, a list of the Station bulletins published prior to December 1, 1905, and a financial report of the Secretary of the Board of Trustees.

WINTHROP E. STONE,

December 1, 1905. President.

Board of Control,

William V. Stuart, President,	LaFayette, Tippecanoe County
Sylvester Johnson,	Irvington, Marion County
David E. Beem,	Spencer, Owen County
Job H. VanNatta,	LaFayette, Tippecanoe County
James M. Barrett,	Fort Wayne, Allen County
Charles Downing,	Greenfield, Hancock County
Christian B. Stemen,	Fort Wayne, Allen County
Charles Major,	Shelbyville, Shelby County
Addison C. Harris,	Indianapolis, Marion County

Winthrop E. Stone, A. M., Ph. D., President of the University

STATION STAFF.

December 1, 1905.

Arthur Goss, M.S., A.C.,*	Director, Station Chemist, State Chemist
William C. Latta, M. S.,	Consulting Agriculturist
James Troop, M. S.,	Horticulturist and Entomologist
Joseph C. Arthur, D. Sc.,	Botanist
Hubert E. VanNorman, B. S.,**	Dairy Husbandry
John H. Skinner, B. S.,	Animal Husbandry
Alfred T. Wiancko, B. S. A.,	Agriculturist
Robert A. Craig, D. V. M.,	Veterinarian
Arvill W. Bitting, D. V. M., M. D.,***	Animal Pathology
George W. Spitzer, Ph. G.,***	Poultry Husbandry
Otto F. Hunziker, M. S.,	Dairy Husbandry.
William J. Jones, Jr., M. S., A. C.,	Associate Chemist
Martin L. Fisher, B. S.,	Assistant Agriculturist
Samuel D. Conner, B. S.,	Assistant in Soil Improvement
Owen C. Haworth,*	Assistant Chemist
Charles O. Swanson, M. Agr.,	Assistant Chemist
Frank D. Kern, B. S.,	Assitant Botanist
Henry N. Slater,	Dairy Field Assistant
George I. Christie, B. S. A.,	Assistant in Crop Improvement
Wilber A. Cochel, B. S.,	Assistant in Animal Husbandry
Walter P. Kelley, B. S.,	Assistant Chemist
Nellie Tracy,	Clerk and Librarian
Aldine Pilling,*	Stenographer
Jessie L. Cowing,	Bookkeeper and Stenographer

*Connected with Fertilizer Control.
**Resigned.
***Employed under Special Contract.

Table of Contents.

EIGHTEENTH ANNUAL REPORT

OF THE

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION.

FOR THE YEAR ENDING JUNE 30, 1905.

REPORT OF THE DIRECTOR.

TO PRESIDENT W. E. STONE.

Sir:—I take pleasure in submitting herewith the Eighteenth Annual Report of the Indiana Agricultural Experiment Station. This includes a summary of the work of the different departments for the year ending June 30, 1905, a financial statement of the receipts and expenditures from the Hatch and Miscellaneous funds during the same time and a financial statement of the State Agricultural Experiment fund for the year ending October 31, 1905.

Reorganization of the Work.

On July 1, 1904, two very important changes were made in the organization of the work of the Station. At that time the Station was relieved of the care and management of the Farm, the same being take over by the University. By comparing the financial report included herewith, with that of last year, it will be seen that this change has resulted in a saving to the Station of over $3,000 in the items of labor and feeding stuffs alone. It is to be noted, however, that something like $1,000 of this is offset by a decrease in the sale of farm products. Everything considered, the Station has benefited by this change to the extent of fully $2,000 per annum.

Another change of even greater importance was the placing of the business of the State Chemist's office under the Station organization instead of direct University control, as had been the case in the past. As there is usually a balance of two or three thousand dollars per annum from this source, above all expenses of administering the work, the Station has benefited to this extent by this change. The annual report of the fertilizer control work, of which the work of the office consists almost exclusively, will hereafter be published as one of the regular Station bulletins.

State Appropriation.

By far the most important single event that has occurred in the history of the Station since its organization, was the $25,000 annual appropriation made at the last session of the state legislature. This appropriation has made possible a very much needed extension of the work and will without doubt result in very great benefit to the farmers of the state. The full text of the law creating this appropriation is given below.

Smith Act.

"An Act for the advancement of agriculture; providing for research and investigation in connection with the production of farm products and stock raising, and making an annual appropriation therefor.

Section 1. Be it enacted by the General Assembly of the State of Indiana, That, in order to aid in acquiring and diffusing among the people of the State of Indiana, useful and practical information on subjects connected with agriculture and to promote scientific investigation respecting the principles of agriculture and of agricultural science, the following sums of money are hereby appropriated to Purdue University; for the fiscal year ending October 31st, 1905: $5,000, and $25,000 annually thereafter, said sums to be payable quarterly out of any moneys in the treasury belonging to the general fund not otherwise appropriated, the same to be expended as hereinafter provided.

Section 2. The sum of $5,000 available during the current year, to be expended at the discretion of the director of the experiment station of said university, to advance the general purposes hereinafter specified.

Said sum annually appropriated shall be expended by the agricultural experiment station of said university and in connection with the work of such departments along general lines, as follows, to-wit:

$5,000 in conducting experiments in live stock feeding, having particular regard for beef production.

$5,000 in conducting experiments in crop and soil improvement, including tests of varieties of corn, their adaptability to different soils and different sections of the state, and including fertilizer tests.

$5,000 in experiments and dissemination of results for the advancement of the dairy interests of the state.

$10,000 for the publication and dissemination of results among the people of the state and for advancing the experimental work of

the experiment station and securing needed additions to equipment to accomplish the purposes of this act.

Section 3. The work outlined in this act shall be carried out by the said department of said university along lines to be agreed upon by the director of such department and an advisory committee of three persons, one of whom shall be appointed by the Corn Growers' Association of the State of Indiana, and one of whom shall be appointed by the Dairymen's Association of the State of Indiana, and one of whom shall be appointed by the Live Stock Association of the State of Indiana: Provided, Said advisory committee shall be entitled to no compensation for such services.

Section 4. Whereas, an emergency exists for the immediate taking effect of this act, the same shall be in effect from and after its passage."

Advisory Committee.

In accordance with Section 3, of the Smith Act, an Advisory Committee was appointed by the State Corn Growers' Association, the State Dairymen's Association, and the State Live Stock Association, consisting of the following named persons:

D. F. Maish, Frankfort, representing the State Corn Growers' Association.

Samuel Schlosser, Plymouth, representing the State Dairymen's Association.

W. R. Pleak, Greensburg, representing the State Live Stock Association.

On April 11, the above Committee met with the Director of the Station, at which time the organization of the State work was discussed, and the plans which are being carried out at present were approved. An account of the work accomplished up to date, in accordance with the plans approved at this time, will be found elsewhere in this report.

Work of the Station.

The work at the central plant during the year has in general been along the same lines as heretofore. The increased funds have, however, made possible a very material increase in the amount of work accomplished, as indicated by the marked increase in output of publications. A detailed account of the work of the different departments will be found further on.

In accordance with the provisions of the Smith Act, the $5,000

available before November 1, 1905, has all been used in getting ready for, and starting, the work contemplated in the law. This has involved the addition of several new employees, fitting up quarters for them, and arranging for and starting the work at various places in the state.

The organization of the State work has required a large amount of time and thought on the part of the management of the Station and the heads of the departments concerned. It is believed, however, that a very satisfactory organization has been worked out and that a good beginning has been made.

In the live stock feeding division, feeding sheds are being erected to accommodate the animals to be fed next winter and a competent assistant has been employed to take charge of this work under the direction of the head of the Animal Husbandry Department.

In the Dairy division, a competent man has been employed, who is at present actively engaged in visiting the different creameries of the state and aiding in every way possible in the improvement of the methods employed. Cooperative experimental work has also been started in several places in the state.

In the soil and crop improvement division much work has already been done in the way of starting experiments in many places in the state. Competent assistants have been provided for this work and there is every reason to believe that valuable results will be secured in the near future.

The farmers of the state are taking great interest in the extension work and no difficulty is being experienced in securing volunteers to conduct cooperative experiments. In fact, many more farmers are requesting such work than can be accommodated. Most of the work so far arranged is on the basis of variety and fertilizer tests, etc., for a single season, but in a number of places where satisfactory conditions for systematic, scientific work are present, arrangements have been made for series of investigations in soil and crop improvement to run for a number of years. This class of work will be closely supervised by experts from the Station. The Station has been very fortunate in this connection in securing the active cooperation of several former students of the University and other persons having the necessary scientific training and means to insure the success of such work. There can be little doubt that such investigations must ultimately result in much good to the farming and other interests of the state. It will, of course, take several years to solve many of the problems involved, but the results finally secured should certainly be well worth the time and trouble required.

During the time covered by this report, cooperative work has

been started in 183 places in 78 of the counties of the state. The following is a classified list of this work in progress July 1. 1905:

COOPERATIVE WORK IN PROGRESS JULY I, 1905.
Agricultural Department.

1. Breeding Corn for Higher Feeding Value.

Name.	P. O. Address.	County.
J. V. McKnight,	Veedersburg,	Fountain.
L. B. Clore,	Franklin,	Johnson.
J. D. Whitesides,	Franklin,	Johnson.
H. M. Stout,	Trafalgar,	Johnson.
Jacob Orth & Sons,	Edwards,	Vigo.

2. Breeding Corn for General Seed Purposes.

L. B. Clore,	Franklin,	Johnson.
H. M. Stout,	Trafalgar,	Johnson.
Q. A. Blankenship,	Paragon,	Morgan.
J. H. Goss,	Paragon,	Morgan.
S. W. Little Coal Co.,	Littles,	Pike.
Worth Osborn,	Winchester,	Randolph.
C. L. Mace & Son,	Scottsburg,	Scott.
Prof. E. E. Reynolds,	LaFayette,	Tippecanoe.
F. P. Hoopergardner,	Ossian,	Wells.

3. Tests of Varieties of Corn.

Lorenzo Tinkham,	Monroe,	Adams.
Robt. D. Beevy,	Decatur,	Adams.
W. F. Johnson,	Monroeville,	Allen.
George V. Kell,	Huntertown,	Allen.
A. J. Steury,	New Haven,	Allen.
T. E. Ellison,	Fort Wayne,	Allen.
O. E. Cook,	Taylorsville,	Bartholomew.
C. E. Talkington,	Elizabethtown,	Bartholomew.
J. D. Hooker,	Talbot,	Benton.
Grant Schneck,	Lebanon,	Boone.
Ottis Crane,	Lebanon,	Boone.
J. C. Setser,	Helms,	Brown.
Wm. R. Myer,	Yeoman,	Carroll.
Lloyd Wolverton,	Flora,	Carroll.

G. W. Winiger,	Galveston,	Cass.
Ulysses Adams,	Marysville,	Clark.
D. L. Goss,	Borden,	Clark.
A. L. Cook,	Frankfort,	Clinton.
J. W. Kemp,	Kirklin,	Clinton.
J. C. Fairhurst,	Plainville,	Daviess.
A. B. Osman,	Plainville,	Daviess.
J. E. Peek,	Washington,	Daviess.
R. H. Martin,	Moores Hill.	Dearborn.
Simon Zinser,	Guilford,	Dearborn.
O. J. Butler,	Greensburg,	Decatur.
W. M. Sharp,	Westport,	Decatur.
Walter Mertz,	Corunna,	DeKalb.
C. O. Spencer,	Muncie,	Delaware.
D. B. Blazer,	Eaton,	Delaware.
Jos. Laudrey,	Yorktown,	Delaware.
Henry Lammers,	Holland,	Dubois.
W. C. Gates,	Lyons Station,	Fayette.
C. F. Kerr,	Connersville,	Fayette.
Spronson Wilson,	Covington,	Fountain.
C. H. Carwile,	Covington,	Fountain.
Paul Miller,	New Trenton,	Franklin.
Geo. W. Klipple,	Brookville,	Franklin.
H. L. Harsh,	Rochester,	Fulton.
J. E. Henderson,	Akron,	Fulton.
W. S. Glessner,	Swayzee,	Grant.
Jesse Clanin,	Swayzee,	Grant.
W. G. Jones,	Lyons,	Greene.
Miss Marcia Ogle,	Lyons,	Greene.
Lincoln Cox,	Sheridan,	Hamilton.
Geo. B. Quibbeman,	New Salisbury,	Harrison.
J. S. Pfrimmer,	Corydon,	Harrison.
Geo. W. Christie,	Hadley,	Hendricks.
R. S. Cline,	Coatesville,	Hendricks.
E. R. Hines,	New Castle,	Henry.
U. G. Garrett,	Kokomo,	Howard.
John Buckingham,	Huntington,	Huntington.
J. M. Settlemeyer,	Huntington,	Huntington.
Roy Strouse,	Huntington,	Huntington.
M. E. Lutes,	Freetown,	Jackson.
J. B. Johnson,	Crothersville,	Jackson.
A. L. Bank,	Wheatfield,	Jasper.
M. E. Harkins,	Portland,	Jay.

T. S. Roseberry,	Deputy,	Jefferson.
Jacob Snyder,	Kent,	Jefferson.
G. W. Bowman,	Grayford,	Jennings.
J. W. Yoke,	Acton,	Johnson.
A. T. Cook,	Warsaw,	Kosciusko.
C. B. Benjamin,	LeRoy,	Lake.
Michael Schreiber,	Cedar Lake,	Lake.
L. A. Warner,	Hanna,	LaPorte.
John Granzow,	LaPorte,	LaPorte.
W. G. Osborn,	Wanatah,	LaPorte.
Ralph Stipp,	Bedford,	Lawrence.
U. C. Reeves,	Markleville,	Madison.
Thomas J. King,	Alexandria,	Madison.
Chas. Furnas,	Valley Mills,	Marion.
Dr. J. M. Beraner,	Indianapolis,	Marion.
G. C. Graverson,	Bremen,	Marshall.
Ray Kennedy,	Dover Hill,	Martin.
L. B. Hunt,	Amboy,	Miami.
Ed. Henderson,	Wagoner,	Miami.
E. E. Crouder,	Bunkerhill,	Miami.
J. W. Kunkel,	Wingate,	Montgomery.
E. B. Welsheimer,	Crawfordsville,	Montgomery.
R. E. Anderson,	Martinsville,	Morgan.
Q. Blankenship,	Paragon,	Morgan.
Warren Myers,	Kentland,	Newton.
B. A. Constable,	Goodland,	Newton.
F. J. Darrow,	Kendallville,	Noble.
L. E. Thomas,	Kendallville,	Noble.
Henry Cox,	French Lick,	Orange.
M. H. Brown,	Velpen,	Pike.
S. W. Little,	Littles,	Pike.
A. B. Lantz,	Valparaiso,	Porter,
Wm. J. Johnson,	New Harmony,	Posey.
L. W. Wade,	Wadesville,	Posey.
S. Chapman,	Winamac,	Pulaski.
Louis Staddon,	Monterey,	Pulaski.
T. C. O'Hair,	Greencastle,	Putnam.
F. R. Williams,	Cloverdale,	Putnam.
E. H. Ellis,	Greencastle,	Putnam.
Hezekiah Fowler,	Union City,	Randolph.
Worth Osborn,	Winchester,	Randolph.
B. F. Lucas,	Lynn,	Randolph.
R. P. Lamb,	Milan,	Ripley.

W. M. Turner,	Sunman,	Ripley.
Louis Pfieffer,	New Carlisle,	St. Joseph.
W. B. Calvert,	South Bend,	St. Joseph.
W. E. Everhart,	Austin,	Scott.
A. G. Mace,	Lexington,	Scott.
Bert Boals,	Shelbyville,	Shelby.
Mel Swallow,	Rockport,	Spencer.
J. F. Schraeder,	Hamlet,	Starke,
A. O. Glass,	Culver,	Starke.
Frank Heilman,	North Judson,	Starke.
B. Sarber,	Knox,	Starke.
F. G. Salisbury,	Orland,	Steuben.
Clinton Murdock,	Sullivan,	Sullivan.
F. M. Cunningham,	Sullivan,	Sullivan.
Peter Nance,	LaFayette,	Tippecanoe.
E. M. Elliott,	LaFayette,	Tippecanoe.
Jas. McNeeley,	Ashgrove,	Tippecanoe.
Willie Essig,	Tipton,	Tipton.
C. G. Clem,	Windfall,	Tipton.
J. N. McMahan,	Liberty,	Union.
Wm. McDowell,	Inglefield,	Vanderburg.
Louis Seiffert,	Evansville,	Vanderburg.
H. H. James,	Hillsdale,	Vermillion.
Henry Watkins,	Lewis,	Vigo.
B. W. Dickens,	Lafountaine,	Wabash.
Jos. W. Heher,	North Manchester,	Wabash.
Wm. P. Aiken,	Newburg,	Warrick.
W. O. Huston,	Salem,	Washington.
S. Chastain,	Campellsburg,	Washington.
Thomas Cain,	Economy,	Wayne.
F. O. Underhill,	Greens Fork,	Wayne.
A. L. Baldwin,	Webster,	Wayne.
Chas. Raber,	Bluffton,	Wells.
M. E. Teeter,	Monticello,	White.
L. McDonald,	Monticello,	White.
Hiram Wise,	Idaville,	White.
Guy McMullen,	Idaville,	White.
J. D. Sherwood,	Columbia City,	Whitley.
Lewis Mishler,	Collamer,	Whitley.
W. H. Favinger,	Churubusco,	Whitley.

4. Methods of Cultivating Corn.

Senator R. W. Moss,	Ashboro,	Clay.

5. Tests of Leading Varieties of Winter Wheat.

W. A. Toms,	Straughn,	Henry.
C. P. Volle,	Edwardsport,	Knox.
G. C. Graverson,	Bremen,	Marshall.
C. L. Mace & Son,	Scottsburg,	Scott.
Jacob Orth & Sons,	Edwards,	Vigo.

6. Tests of Leading Varieties of Soy Beans and Cow Peas.

C. F. Kerr,	Connersville,	Fayette.
S. W. Little Coal Co.,	Littles,	Pike.
C. L. Mace & Son,	Lexington,	Scott.
E. C. Salisbury,	Orland,	Steuben.

7. Tests of Leading Varieties of Oats.

R. O. Stipp,	Bedford,	Lawrence.

8. Alfalfa Experiments—Method of Seeding—Inoculation.

P. C. Lamberson,	Michigantown,	Clinton.
C. F. Kerr,	Connersville,	Fayette,
C. P. Volle,	Freelandsville,	Knox.
Jerome Zechiel,	Culver,	Marshall.
Herbert Test,	Peru,	Miami.
J. W. Kunkle,	Waynetown,	Montgomery.
J. J. A. Alter,	Goodland,	Newton.
S. W. Little Coal Co.,	Littles,	Pike.
Oliver Test,	Richmond,	Wayne.
H. H. Peter,	Monticello,	White.
O. B. Whistler,	Chalmers,	White.

Chemical Department.

1. Fertilizer Tests With Corn.

S. D. Conner,	Nulltown,	Fayette.
Ovid Fields,	Lyons,	Greene.
B. J. Gifford,	Newland,	Jasper.
G. H. Thomas,	Pleasant Ridge,	Jasper.
Chas. Juengst,	North Vernon,	Jennings.

S. W. Little Coal Co.,	Littles,	Pike.
Sid Conger,	Anderson,	Madison.
J. C. Hodges,	Paragon,	Morgan.
American Farm C	Morocco,	Newton.
Paul Conger,	Shelbyville,	Shelby.
E. E. Jones,	Newtonville,	Spencer.
L. G. Nice.	Battle Ground,	Tippecanoe.
Otto Gresham,	Ambia,	Warren.
A. A. Cravens,	Hardinsburg,	Washington.

2. Fertilizer Tests with Wheat.

D. C. Pfendler,	Acton,	Marion.
A. G. Mace,	Lexington,	Scott.
O. W. Caswell,	Boonville,	Warrick.

3. Fertilizer Tests with Oats.

M. E. Hamlin,	Boswell,	Benton.

4. Fertilizer Tests with Potatoes.

Joseph Hickman,	Springport,	Henry.

5. Fertilizer Tests with Onions.

James Fowler, Jr.,	Fowler,	Benton.
A. A. Laughlin,	Nappanee,	Kosciusko.

Horticultural Department.

Tests of Small Fruits.

I. M. Snodgrass,	Kirklin,	Clinton.
O. C. Carter,	Seymour,	Jackson,
H. H. Swain,	South Bend,	St. Joseph.

Dairy Department.

Herd Tests.

W .J. Balkama,	LaFayette,	Tippecanoe.
D. B. Skiles,	Rossville,	Tippecanoe.

Station Staff.

On account of the reorganization of the work and the state appropriation already noted, a number of additions have been made to the Station Staff. The employees transferred from the State Chemist's office were as follows: Arthur Goss, State Chemist; W. J. Jones, Jr., Chief Deputy State Chemist; O. C. Haworth, Deputy State Chemist; Aldine Pilling, Stenographer, and James Eldridge, Helper.

On April 1, W. E. Osborn was employed as Working Foreman on the Experiment Farm. On April 18, Nola Sparks was added as Bookkeeper and Stenographer in the Director's office. On April 25, C. O. Swanson, a graduate of the Minnesota Agricultural College was added to the Station Staff as Assistant Chemist, and on May 1, S. D. Connor, formerly Deputy State Chemist, was transferred to the State work with the title of Assistant in Soil Improvement. On May 1, F. D. Kern, a graduate of the Iowa Agricultural College, was added to the Staff as Assistant Botanist. On June 15, H. N. Slater was transferred from the University Dairy work to the State work, as Dairy Field Assistant.

Since the time covered by this report, several other persons have been added to the working force of the Station, note of which will be made in next year's report. A complete list of the Staff as organized December 1, 1905, will be found on page 3 of this report.

Publications.

During the year covered by this report, seven regular bulletins and six press bulletins, have been issued. During only one year, namely 1888-9, were a greater number of bulletins issued, while in total number of pages the bulletins of this year contained over twice as many as those of any previous year.

A number of this year's bulletins have received very favorable comment from farmers, the agricultural press and others. The following is a list of the bulletins published this year.

Bulletins Published by the Experiment Station for the Year Ending June 30, 1905.

Bulletin No. 100, Vol. XII, September, 1904, pp. 69-204. Illustrations 23. Diseases of Swine. By R. A. Craig and A. W. Bitting.

Bulletin No. 101, Vol. XII. February, 1905, pp. 205-219. Alfalfa in Indiana. By A. T. Wiancko and M. L. Fisher.

Bulletin No. 102, Vol. XII. March, 1905, pp. 220-254. Illustrations 8. Apple Growing in Indiana. By J. Troop.

Bulletin No. 103. Vol. XII. March, 1905, pp. 255-264. Rapid Method of Removing Smut from Seed Oats. By J. C. Arthur.

Bulletin No. 104. Vol. XII. March, 1905, pp. 265-274. Illustrations. 2. A Simple Alkali Test for Ripeness of Cream. By H. E. VanNorman.

Bulletin No. 105, Vol. XII. March, 1905, pp. 275-322. Illustrations 14. Corn Improvement in Indiana. By A. T. Wiancko.

Bulletin No. 106, Vol. XII. May, 1905, pp. 52. Maps 1. Commercial Fertilizers. By Arthur Goss and W. J. Jones, Jr.

Report—Seventeenth, July 1, 1903 to July 1, 1904, pp. 38. By Arthur Goss, Director.

NEWSPAPER BULLETINS PUBLISHED BY THE EXPERIMENT STATION DURING THE YEAR ENDING JUNE 30, 1905.

No. 113, August 25, 1904. Results of Variety Tests of Winter Wheat. By A. T. Wiancko.

No.. 114, October 1, 1904. Farmers 'Excursion to Purdue University and the Agricultural Experiment Station. By Arthur Goss.

No. 115, February 1, 1905. What the Station is. By Arthur Goss.

No. 116, March 14, 1905. Test your Seed Corn. By A. T. Wiancko.

No. 117, April 5, 1905. Is Soil Inoculation Necessary? By A. T. Wiancko.

No. 118, May 5, 1905. Muck Lands and How to Make Them Pay. By W. J. Jones, Jr.

Mailing List.

In the table given below will be found the classified mailing list of the Station for the last three years, as it stood July 1. By referring to this table it will be seen that 1702 names have been added during the year covered by this report, while during the year previous there were but 641 additions. As no greater effort than usual was made during the past year to increase the mailing list, it would seem that this increase might indicate an increasing appreciation of the work of the Station by the farmers of the state and others. The Station would be glad to still farther add to the list, and will take pleasure in sending the bulletins regularly to any one interested in farming, in the state, who will write to the Director of the Station and request that his name be placed on the mailing list.

MAILING LIST FOR THE LAST THREE YEARS.

	1902-3	1903-4	1904-5
Names of persons in Indiana	6,870	7,227	8,254
Names of persons outside of state	1,293	1,539	2,211
Names of persons in foreign countries	173	196	197
Indiana periodicals	603	600	589
Outside state periodicals in U. S.	144	154	160
Periodicals (foreign)		8	15
Total	9,083	9,724	11,426

On the whole, the year just closed has been decidedly the most important in the history of the Station. The changes in organization and the State appropriation have resulted in very materially relieving the financial stringency existing heretofore. These changes have already resulted in a decided improvement in the work of the Station and there is apparently no reason why this improvement should not continue in increasing extent.

The most urgent need at the present time, which cannot be met by funds in sight, is for a new building. This is a very serious matter, as pointed out in the annual reports of the Station for a number of years past. With the present unsafe, poorly constructed building as an essential factor in the calculation, it is impossible to figure on permanent improvements in the equipment of the Station building, such as are urgently demanded by the increase in the work. It is hoped that this very unsatisfactory state of affairs may be relieved in the near future.

Respectfully submitted,

ARTHUR GOSS, Director.

REPORT OF THE AGRICULTURAL DEPARTMENT.

Arthur Goss, Director.

Sir:—I beg to submit the following report of the work of the Agricultural Department for the year ending June 30, 1905:

Experiments on the Station Farm.

The work of the Department on the Station Farm, as reported last year, is progressing favorably. All the experiments then in progress are being continued, and some new lines of work have been undertaken.

Experiments similar to those in wheat breeding have been started with oats and soy beans. In all three cases the object is to so improve or alter the qualities of leading varieties as to make them better adapted to Indiana conditions, and the requirements of the Indiana farmer. In the case of wheat and oats, rust resistance and stiffness of straw are receiving special attention, as weakness in these respects is very detrimental to both yield and quality. Special attention is being given also to the milling qualities of the wheats used in the breeding plots. Enough of such work has been done to show that wonderful improvements along these lines are possible. We have as yet little evidence as to what can be done in the way of breeding wheat so as to make it able to resist the attacks of the Hessian Fly. A ray of light was apparently thrown upon the subject last year, and we seem to be justified in believing that by careful selection of seed plants through a series of years, considerable resisting power may be developed.

An important object in the breeding work with soy beans, is to produce strains that will bear their pods higher up from the ground, and on branches rather than on the main stems. Important differences between individual plants indicate that in this work much may be accomplished in a comparatively short time. A greater number of branches, pods borne higher up, and ability of the pods to hold their beans after ripening, are very important considerations to the producer of this crop. Most varieties are weak on these points, and we hope to considerably improve those which are otherwise best adapted to our conditions.

Some interesting data are being secured upon the effect of limited nutrition on the tendency to barrenness in corn, showing that poor nutrition, while causing a small growth and poor quality generally, has a very marked effect in increasing the percentage of barren stalks. Variations of from one-half of one per cent, to over forty per cent, according to amount of nourishment received per stalk, have been observed.

Cooperative Experiments.

The appropriation of funds by the State Legislature to the Station for experimental purposes, has made it possible to very materially increase the work of this department out in the State. It will now be possible to go into every important crop producing section of the State, and establish experimental plots with a view to introducing and improving varieties of all important crops, with special adaptations to local conditions. The number of tests of varieties of corn, was increased this year from forty to one hundred

and forty, reaching seventy-eight of the ninety-two counties in the state. In each of these tests, from six to eight of the varieties which seemed to give greatest promise for the locality were tested. The great value of these local variety tests lies in bringing to the notice of farmers important differences between varieties, and leading them to select those which show superiority. This work will also yield valuable service in leading farmers into taking a greater interest in all kinds of experimental work with a view to improvement. But variety testing does not go far enough in serving local needs. With a view to bringing about more rapid improvements in corn, a number of breeding plots have been established in important corn growing sections, and special attention is being given to producing strains of corn that will give larger yields of greater uniformity and better quality. Eleven such plots have been established, and next year the number will be considerably increased. Our farmers seem glad to take up this kind of work, and are quite willing to furnish the ground and all necessary labor, while this department selects and prepares the seed, keeps the records, and furnishes directions and expert supervision and assistance in the work.

The number of cooperative experiments with winter wheat, soy beans, cow peas, etc., has also been increased. All this work bids fair to aid very materially in the betterment of Indiana agriculture.

Publications.

The following bulletins were prepared in this Department and published during the year:

Pamphlet bulletins, No. 101, Alfalfa in Indiana; No. 105, Corn Improvement in Indiana.

Newspaper bulletins, No. 113, Results of Variety Tests of Winter Wheats; No. 116, Test Your Seed Corn; No. 117, Is Soil Inoculation Necessary?

Respectfully Submitted,

A. T. Wiancko, Agriculturist.

REPORT OF THE HORTICULTURAL DEPARTMENT

Arthur Goss, Director.

Sir:—The experimental work of the Horticultural Department has been varied somewhat during the past year from that of previous years, although much of the work is of a continuous nature, so that we can only report progress. The Orchard fertilizer experiments reported one year ago, one in the north and one in the south end of the state are of this nature.

"Pedigreed" Strawberry Plants.—Much has been published of late concerning the value of so-called pedigreed strawberry plants. Hence, an experiment was started one year ago, to demonstrate if possible, the facts in the case. Accordingly plants were obtained from "pedigreed" stock of four of the leading varieties of strawberries, viz: Bubach, Haverland, Aroma and Clyde, and plants of the same varieties were obtained from six different growers living in five different states, all of whom propagate their plants in the usual way. These plants were planted side by side, and all given the same kind of treatment. While the results of a single season may not prove anything definite, they indicate very clearly in this case that the "pedigree" theory, as applied to strawberry plants, has been overdone. The same experiment will be continued another season.

Commercial fertilizers on Tomatoes.—This experiment was tried for the purpose of noting the effect of a single application of fertilizer on the growth and yield of the plants. The application was made at the time of setting the plants and at the following rate per acre:

Acid Phosphate..........	250 pounds.
Muriate of Potash........	250 pounds.
Nitrate of Soda..........	300 pounds.

This was scattered around the plants, and harrowed in. The results are not as satisfactory as they doubtless would have been had they not been interfered with by a drouth in the midst of the fruiting season. There were 228 plants in the experiment, and the fruit of each plant was picked and weighed separately during the ripening season.

In connection with the above experiment, a variety test was made by running the rows of each variety (nineteen in number) crosswise of the fertilizer plats. One of the most interesting results obtained was that showing the variableness in the productive qualities of individual plants, some plants being more than four times as productive as others of the same variety in the same row. This was not wholly due to a different kind of fertilizer, because in some instances the yield was greater on plants which received no fertilizer, than on those which were fertilized and standing in the adjoining row. Here seems to be a large and inviting field for the plant breeder.

Spraying Experiments.—Our spraying experiments have been conducted for the most part against the codling moth and the San Jose scale. It was formerly supposed that the most good could be accomplished by spraying early for the codling moth, but our later experiments seem to indicate that it is just as im-

portant to spray for the second brood as it is for the first. The spraying for the second brood should be done between the first and middle of August.

The San Jose scale has been found in 44 counties in this state, and we now have under way experiments with several different mixtures, all of which are said to be sure death to the scale. In our next report we hope to have something definite on this subject.

Greenhouse culture of tomatoes and lettuce.—Owing to the unreliable method of heating the greenhouse last winter, our experiments with tomatoes and lettuce were interfered with to such an extent as to make it undesirable to publish results.

A New Aphid.—During the summer of 1904 plant lice were found to be very abundant in a field of Houghton gooseberries, near the city of Indianapolis. The peculiar manner in which they worked attracted attention, and specimens were taken and sent to Dr. L. O. Howard at Washington, who pronounced the aphid a new species, and drawings were accordingly made by Mr. Heidemann, of the Division of Entomology.

In the field of gooseberries, there were scattering plants of another variety, and it was noticed that none of these plants were infested by the aphis. I then made several attempts during the summer of 1904 and also of 1905 to colonize them on various other varieties of gooseberry, but in no case did I succeed in inducing them to feed. They multiplied so rapidly, however, upon the Houghton, that the owner was obliged to give up the fight after two seasons' experience and destroy the entire five acres of plants. Hence, I have designated it as *Aphis Houghtonensis.*

Description: The wingless females of the summer broods are about one-sixteenth of an inch in length, of a pale green color; eyes prominent; antennae and legs of a yellowish tint and covered with scattering short spines, except the terminal joint of the antennae; antennae a little more than half the length of the body. Honey tubes prominent, nearly as long as from their base to the tip of the abdomen. The winged forms measure nearly three-sixteenths of an inch to the tip of the wings when folded; color of the wings and body a shade darker than the wingless forms; antennae nearly one half larger than the body; spread of wings, three times the length of the body; eyes somewhat darker than the wingless forms while the legs are not so spiney; honey tubes about the same length in both forms.

Respectfully submitted,

JAMES TROOP,
Horticulturist.

REPORT OF THE CHEMICAL DEPARTMENT.

Arthur Goss, Director.

Sir:—The following is a brief account of the work of the Chemical Department for the year ending June 30, 1905.

General Work.

1. The study of the corn plant under different conditions of moisture and fertilization was continued. The harvest of the plats in November, 1904, showed a marked difference in the crop produced on the irrigated and unirrigated portions, the former giving much larger yields. The severe windstorm the latter part of August blew down the corn so badly that it was deemed inadvisable to take samples with a view to ascertaining the points set forth in the previous report. The present season has been exceptional as regards moisture and atmospheric conditions and while from the standpoint of irrigation, not much information may be obtained, it is hoped that considerable data may be secured regarding the composition of the corn plant under different kinds of fertilization.

2. The cooperative experiments with the Bureau of Chemistry, U. S. Department of Agriculture, on the influence of environment on the composition of the sugar beet was concluded and the results published in bulletins No. 95 and No. 96 of that Department.

3. The investigation of the effect of fertilization on the growth and composition of the sugar beet was concluded.

4. The investigation of the composition of the water underlying muck soils at different seasons and its possible influence on the growth of crops was continued.

5. The investigation in cooperation with the Agricultural Department in corn breeding was continued. One hundred and sixty-one samples of corn were analyzed, necessitating 322 determinations of moisure, 322 determinations of nitrogen, and 253 determinations of fat. A part of the results obtained appear in Bulletin No. 105.

6. An investigation in cooperation with the Dairy Department concerning the moisture content of butter under different conditions of manufacture was continued. Complete analyses of several samples of butter were also made for the Dairy Department. In connection with this work, original methods of manipulation for determining the curd and salt were devised. A sample of milk preservative was also analyzed for the Dairy Department and the amount of corrosive sublimate necessary to preserve

samples of milk while awaiting tests in the creamery, was determined.

7. Samples of stock food, including Linden Stock and Pulp Company's feed, hominy chops, and other feeds were analyzed for the Animal Husbandry Department, and various farmers.

A sample of cattle food received from Mr. C. O. White, Ossian, Ind., and said to retail at Ossian at seven cents per pound, gave the following results on analysis:

Moisture at 100° C.	%	0.49
Sodium Chloride (NaCl) common salt	%	96.73
Iron (Fe)	%	0.71
Sulfur tri-oxide (SO_3)	%	0.19
Carbon (C)	%	1.51
Ash	%	0.34
Total	%	99.97

The sulfur tri-oxide was probably present as sodium sulfate, (an impurity in the salt). The carbonaceous matter was doubtless used to color the mixture, thus preventing recognition of the main ingredient—*salt*.

At the time this material was analyzed, March 20, 1905, a barrel of salt containing 280 pounds retailed in LaFayette for $1.10, which would make the actual cost of the mixture less than one-half cent per pound.

The above is only one example of many coming to our notice, emphasizing the need of a law regulating the sale of cattle foods, similar to our fertilizer law, providing for a guarantee by the manufacturer and rigid inspection and chemical control.

8. The work of the Associate Chemist, begun some years ago in cooperation with Professor H. A. Huston, on the effect of varying conditions of time, temperature, acidity, alkalinity, volume and dilution on the solubility of natural phosphates in neutral ammonium citrate and citric acid solutions has made but little progress the past year owing to lack of time, which made necessary a large amount of routine work and prevented the giving of time to the completion of the investigation.

Some 13 natural phosphates have already been examined, and it is hoped that time will soon be obtained to conclude the investigation, which in addition to the original work planned, has been extended to include the complete analyses of all materials examined. For the latter part of the work a large amount of investigation will be required in devising trustworthy methods.

9. In connection with the analytical work of the fertilizer control, there has been carried on an investigation as to the best

methods of preparing neutral ammonium citrate. This has included a comparison of different indicators. the calcium chloride and corrallin method of neutralization, the determination of ammonia per liter in each citrate solution prepared in the laboratory for the past 12 years, a study of methods for determining citric acid in ammonium citrate solution, and the preparation of C. P. solutions of neutral ammonium citrate specific gravity 1.09.

An attempt is now being made to devise means whereby a theoretical solution of neutral ammonium citrate of specific gravity 1.09 can be prepared, using the required amount of C. P. citric acid and ammonia of 0.96 specific gravity, the difficulty of preparing such a solution being due to the danger of loss of ammonia from so strong a solution.

Cooperative Work.

The cooperative fertilizer test work has been continued during the year, and owing to increased funds from the State appropriation, has been considerably extended. On July 1, fertilizer tests were being conducted in 21 places in the state and arrangements have since been made for such work in a number of other places. A list of the work in progress July 1 will be found elsewhere.

This work in a number of places is much more comprehensive than a simple fertilizer test for a single season. The investigations of the cause and method of improving the unproductiveness of muck soils, for example, which was started in Tippecanoe county in 1902, and in Newton county in 1904, involves tests of a variety of substances, such as a number of different potash compounds and of phosphoric acid, nitrogen, lime. soda and magnesium sulfate, sodium chloride, ferric hydrate. ferrous sulfate, lamp black, straw and manure. These tests also include a study of the residual effects of the various fertilizers. This work will be continued for a number of years.

Similar investigations are also in progress in other parts of the state on different types of soils, and with several different crops. In several places studies are being made of the comparative effects of acid phosphate and raw rock phosphate. Also the effects of other forms of phosphoric acid, different forms of nitrogen, potash and lime, and of manure and legume crops. These series are also to run for a number of years. It is not necessary to enter into a detailed discussion of this work at this time, as the same will be published in bulletin form in the near future.

In connection with the fertilizer test work, samples of soil are being taken and analyzed in order to determine what relation exists between the composition of the soil and its fertilizer re-

quirements. During the year covered by this report, 25 such samples have been analyzed. These analyses will be published later in bulletin form.

State Chemist Work.

The work of administering the fertilizer law was transferred from the University to the Station on July 1, 1904, and a large amount of the time of the Chemical Department has been devoted to carrying out the provisions of the fertilizer law.

Practically every county in the state where fertilizer was used has been visited by our deputies who are on the road about six weeks in the spring and from six to eight weeks in the fall collecting samples, the remainder of the year being spent in analyzing the samples obtained.

In the fall of 1904, 430 sampes were taken, and in the spring of 1905, 318 samples. The analyses of these samples involved 1160 determinations of total phosphoric acid, 1007 determinations of insoluble phosphoric acid, 868 determinations of nitrogen, and 771 determinations of potash.

The poor wheat crop of 1903 reduced the sale of fertilizer in the fall of 1904, but the good prospects for a crop this season and the increase in the use of fertilizer on corn, and by the growers of onions and potatoes, caused a large increase in the amount of fertilizer used in the spring of 1905, the sales being unequalled by the spring sales of any preceding year.

Owing to the decreasing revenue as the result of low sales in 1903 and 1904, the laboratory has been forced to run with two less assistants than are really required to handle the work.

The office work and letters requesting information regarding fertilizer questions have increased to such an extent that nearly the entire time of the Chief Deputy has been demanded in attending to the same.

A number of affidavits have been filed with the prosecutors in accordance with instructions given to deputies to file affidavits in every case of the violation of the fertilizer law.

The work of the Department is in excellent condition. The results of the analyses of the inspection samples collected during the fall of 1904 have already been published as a part of Bulletin No. 106, and the analyses of the samples collected last spring are well under way, and the advance reports will soon be sent to the manufacturers and agents.

Respectfully submitted,
ARTHUR GOSS, Chemist.
W. J. JONES, JR., Associate Chemist.

REPORT OF THE BOTANICAL DEPARTMENT.

Arthur Goss, Director.

Sir:—During the year ending June 30, 1905, the work of the Botanical Department has been almost wholly devoted to the study of parasitic fungi, and the diseases caused by them. However, during this period a reminder of former work done in the domain of vegetable physiology was received in form of two diplomas from the Universal Exposition of 1904 at St. Louis. One of these confers a bronze medal for a "centrifuge to illustrate the effect of gravity on growing plants, specially designed by J. C. Arthur," and the other confers a gold medal for "recording apparatus for physiological study of plants, devised by J. C. Arthur." This apparatus exhibited at St. Louis was the outgrowth of work in the department, and it is hoped that time and opportunity may be found in the near future to resume this line of investigation, which is now in its infancy as an agricultural subject, but promises great and fundamental service when suitably developed.

Plant Rusts. The utmost effort has been concentrated upon the study of the rusts of all classes of plants. The object has been to obtain as wide a range of knowledge as possible of this class of parasitic fungi, especially of those species having agricultural importance. It is hoped by this means to secure new points of view for attacking the difficult problem of the grain rusts in particular, and for illuminating the obscure behavior of other rusts of field and garden crops, a hope not altogether unrealized, although the work is not yet approaching completion. Cooperation with the U. S. Department of Agriculture much increased the amount of work accomplished, as it made possible practically the entire time of an assistant from July 1, 1904, until April 30, 1905. Since May 1, when this portion of the cooperative agreement with the Department was dissolved, the assistant has been a regular member of the Station Staff. During July, August and September, Mr. J. C. Marquis most acceptably occupied the position, and resigned to accept an editorial position in connection with the agricultural publications of the Orange Judd Co. Since his resignation the position has been held by Mr. Frank D. Kern, whose ability in this line of research is of an unusually high order.

The work has resulted in two important articles of a fundamental nature. One of these was published in the *Botanical Gazette* for March, 1905, under the title "Terminology of the spore-structure in the Uredinales," and proposed new terms for the several

forms of spores, thus releasing such generic names as *Uredo* and *Aecidium*, heretofore applied to certain spore-forms, as well as unifying and simplifying all the terms employed. According to the suggestion of this paper, the several stages of every rust having complete development, like stem rust of wheat, for instance, would show in the order of their appearance, *pycinia*, *aecia*, *uredinia* and *telia*, the aecia being cluster cups, the uredinia being red rust and the telia black rust. The second of these articles was presented at the International Botanical Congress held at Vienna in June, 1905, and embodied a new classification of the whole group of rusts, founded upon their life history and structure, designed to bring out in a clearer and more recognizable form the most salient relationships of all the forms. The paper will appear in the proceedings of the Congress, which have not yet been printed.

Among the many cultures of grass and sedge rusts carried out last spring, those confirming the work on corn rust of the preceding year, and mentioned in the last Annual Report of this Station, are of special moment. The resting spores of the rust taken from the dead leaves of the previous season were sown in April on young plants of the wild yellowed-flowered wood sorrel and readily produced the cluster cup stage; this was in turn sown on corn and produced the red rust. At the same time the resting spores from the corn were sown directly on young corn plants raised in the greenhouse, and although the trials were repeated, yet no infection resulted. It is therefore firmly established that the full life cycle of corn rust requires sorrel for its completion. From some observations made by the Department, together with information gleaned elsewhere, it is inferred nevertheless, that much of the corn rust, even in northern regions, starts in the early part of the season from the red rust spores which have been so fortunate as to survive the winter, and grown directly upon the young corn plants, and that most of the resting spores come to nought, but this is a point yet to be investigated by the Department. It was also found this season that the rust passed readily from field corn to sweet corn, or the reverse, showing in all probability that there is only one species of corn rust capable of passing readily from one kind of corn to another. Other cultures of grass rusts might be mentioned, such as finding the cluster cup stage of the cord grass (*Spartina*), the study of the behavior of resting conditions of red rust, and adaptation characteristic of hot prairie regions, etc., but would require more space than is here available.

Oat Smut and Its Treatment.—The method of treatment of

seed oats with solution of formalin to free them from smut, doing the work on a large scale at a grain elevator, has been reported in full in Bulletin No. 103, issued in March, 1905. The work is believed to mark a distinct advance in this line of remedial treatment and has received much favorable comment.

Distribution of Fungous Diseases in Indiana.—In the fall of 1904 a circular letter was sent out by the Department to about 90 farmers, orchardists and gardeners of the state, asking information about the prevalence of the most prominent diseases of crops during the year. Some 22 answers were received and a gratifying amount of information obtained, which is being used for a basis for work. It is also contemplated to issue a bulletin of standard information upon the diseases and their remedies which are shown to be most general and injurious.

The Wild Mushroom Crop.—Interest remains unabated in the cultivation of mushrooms, and in the utilization of the edible wild forms. Aside from continuing observations in the field and answering inquiries, no material advance has been made this year by the Department. There still exists the same indispensable need for a suitable mushroom pit or house, in which to carry on experiments, and additional assistance to look after the work.

Letters.—An important part of the work of the Department is devoted to the answering of inquiries about weeds and stray plants, the adulteration of seeds, especially of alfalfa, all kinds of inquiries as to crops and trees, and the identification of grasses. The freedom with which these inquiries are sent is a good index of the existing degree of mutual interest between the people of the state and Department in the special lines of knowledge which it is designed to foster. Respectfully submitted,

J. C. Arthur,
Botanist.

REPORT OF THE ANIMAL HUSBANDRY DEPARTMENT.

Arthur Goss, Director.

Sir:—Below will be found a brief summary of the work of the Animal Husbandry Department during the year ending June 30, 1905.

Soy Beans for Swine.—A manuscript on the use of "Soy Beans, Middlings and Tankage as Supplemental Feeds in Pork

Production" has been completed. This is a report on work done last year and gives the results of a pig feeding experiment, conducted to determine the value of soy beans as a supplement to corn, and compare them with middlings and tankage. The favorable results from the soy beans should make this piece of work of much interest to Indiana farmers and swine growers throughout the state.

Bacon Hogs.—The investigation of this subject has continued during the year. Careful study of the influence of Yorkshire blood on the prolificacy of recognized breeds of lard hogs has been made. A feeding experiment, in which Poland China, Yorkshires, Berkshires and crosses of the same were compared, has been completed. The work on bacon hogs will be continued until sufficient information for publication is obtained.

Milk Production.—Although no special work has been done in this connection, accurate records have been kept of individual cows in the dairy herd, showing milk and butter fat produced and feed consumed.

Beef Production.—Little has been done in this line as the funds appropriated for this work in March, 1905, are not available until November 1, 1905. Plans have been made however, to provide equipment for this work when the funds become available and an assistant has been secured to conduct the work.

A change in the organization of the Experiment Station, July 1, 1904, placed the farm except such areas as may be set aside for permanent experimental purposes, with all equipment of buildings, tools, fences, live stock, etc., together with the proceeds of the same, under University management and maintenance. This change does not relieve the head of this Department of the work and responsibility of managing the farm, but rather adds to his duties, as the change necessitates the keeping of account of all labor, supplies and materials furnished the Experiment Station by the University.

Respectfully submitted,

J. H. SKINNER,

Chief of Animal Husbandry Department.

REPORT OF THE DAIRY DEPARTMENT.

Arthur Goss, Director.

Sir:—During the year the following experiments, among others of less moment, have been carried forward but not fully completed:

One to determine the relative over-run from salted and unsalted or "sweet butter," which was started in a large creamery in northern Indiana.

Another, the making of a marketable cheese from buttermilk from pasteurized cream is being worked out in the Department creamery.

An educational butter scoring, conducted by this Department was begun. Butter is sent to a cold storage house* in Indianapolis from Indiana creameries, to be scored by a commercial judge, and criticisms and suggestions for improvement made by a representative of this Department, and returned to the maker.

A start in cooperative herd testing was made with patrons of our creamery early in the year, and this has been extended to a limited number of outside herds with the purpose of increasing as it may appear that the plan of work meets the needs and existing conditions.

The testing of samples and scoring of butter sent in for criticism, and suggestions made for improvement, have continued.

Mr. H. N. Slater, for some time Buttermaker in the Dairy Department of the University, has been appointed Dairy Field Assistant, to work among the creamerymen and patrons as provided for by the late legislative appropriation. He begins his work at the close of the present fiscal year.

A materially increasing number of inquiries for definite information relating to dairy matters has been answered by letter, and a number of popular articles written for the agricultural press. Bulletin No. 104 on "A Simple Alkali Test for Ripeness of Cream," has been published.

Respectfully submitted,

H. E. VanNorman,

Chief of Dairy Department.

REPORT OF THE VETERINARY DEPARTMENT.

Arthur Goss, Director.

Sir:—A manuscript upon "Examination of Horses for Soundness" has been completed for publication. This work, like the bulletin upon the "Diseases of Sheep," and that upon "The Diseases of Swine," is a result of the joint work with the Office of State Veterinarian. Dr. G. H. Roberts, Assistant State Veterinarian, has contributed a large part of the work.

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*Indianapolis Cold Storage Co.

Another line of work is well under way and will be available the coming year.

Respectfully submitted,
A. W. Bitting,
Veterinarian.

Periodicals.

The following periodicals are on file in the Station Library as regular subscription journals:—

Berichte der Deutschen-Botanischen Gesellschaft..........
....Berlin, Germany.
Botanisches Centrallblatt............Cassel-Marburg, Germany.
Botanische Zeitung..........................Leipsig, Germany.
Bulletin de la Societe Chemique de Paris..........Paris, France.
Centrallblatt fur Bakteriologie..................Jena, Germany.
Chemiker Zeitung..........................Cothen, Germany.
The Entomologist..........................London, England.
Gardeners' Chronicle......................London, England.
Journal of Botany.........................London, England.
Journal fur Landwirthschaft..................Berlin, Germany.
Journal of Comparative Medicine and Veterinary Archives..
....Philadelphia, Pa.
Journal of the Royal Agricultural Society of England......
....London, England.
Journal of the Chemical Society..............London, England.
Landwirthschaftlichen Versuchs-Stationen......Berlin, Germany.
Live Stock Journal........................London, England.
Oil, Paint and Drug Reporter...............New York, N. Y.
Review Mycologie ....London, England.
Veterinarian..............................London, England.
Veterinary Journal........................London, England.
Zeitschrift fur Analytische Chemie........Weisbaden, Germany.

PERIODICALS DONATED.

The publishers of the following periodicals have generously sent them free to the Station during the year. These are leading journals and are frequently used by all persons coming in contact with our library.

AGRICULTURAL PERIODICALS.

Agricultural Advertising - - - Chicago, Ill.
Agricultural Experiments - - - Minneapolis Minn.

American Agriculturist - - -	New York, N. Y.
American Fertilizer - - - -	Philadelphia, Pa.
American Grange Bulletin - -	Cincinnati, Ohio.
American Horticulturist - - -	Wichita, Kansas.
American Swineherd - - -	Chicago, Ill.
Beet Sugar Gazette - - - -	Chicago, Ill.
Blooded Stock - - - - -	Oxford, Pa.
Breeders' Gazette - - - -	Chicago, Ill.
California Cultivator - - - -	Los Angeles, Cali.
Campbell's Soil Culture - -	Lincoln, Neb.
Chicago Dairy Produce - - -	Chicago, Ill.
Chicago Live Stock World - -	Chicago, Ill.
Colman's Rural World - - -	St. Louis, Mo.
Commercial Poultry - - -	Chicago, Ill.
Country Calendar - - - -	New York, N. Y.
Creamery Gazette - - - -	Des Moines, Iowa.
Creamery Journal - - - -	Waterloo, Iowa.
Dairy and Creamery - - -	Chicago, Ill.
Dairy and Produce Review - -	San Francisco, Cali.
Dairy Record - - - - -	St. Paul, Minn.
Dakota Farmer - - - - -	Fargo, N. D.
Dakota Field and Farm - - -	Sioux Falls, S. D.
Deutsch Americkanischer Farmer -	Lincoln, Neb.
Drainage Journal - - - -	Indianapolis, Ind.
Drover's Journal - - - - -	Chicago, Ill.
Elgin Dairy Report - - - -	Elgin, Ill.
Experiment Station Record - -	Washington, D. C.
Farm and Fireside - - - -	Springfield, Ohio.
Farm and Home - - - -	Chicago, Ill.
Farm and Home Sentinel - -	Indianapolis, Ind.
Farm and Live Stock Journal - -	Detroit, Mich.
Farm, Field and Fireside - -	Chicago, Ill.
Farm Folks - - - - -	Kansas City, Mo.
Farm Home - - - - -	Springfield, Ill.
Farm Journal - - - - -	Philadelphia, Pa.
Farm Poultry - - - - -	Boston, Mass.
Farm Star - - - - - -	Indianapolis, Ind.
Farm, Stock and Home - - -	Minneapolis, Minn.
Farm Stock Journal - - - -	Rochester, N. Y.
Farmer and Breeder - - -	Sioux City, Iowa.
Farmers' Advance - - - -	Chicago, Ill.
Farmers' Call - - - - -	Quincy, Ill.
Farmers' Guide - - - -	Huntington, Ind.
Farmers' Home - - - -	Dayton, O.

Farmers' Review - - - -	Chicago, Ill.
Farmers' Sentinel - - - -	Milwaukee, Wis.
Farmers' Tribune - - - -	Sioux City, Iowa.
Farmers' Voice - - - -	Chicago, Ill.
Field and Farm - - - -	Denver, Colo.
Flour and Feed - - - - -	Milwaukee, Wis.
Fruit Grower - - - - -	St. Joseph, Mo.
Hoard's Dairyman - - - -	Ft. Atkinson, Wis.
Holstein-Friesian World - - -	Ithaca, N. Y.
Home and Farm - - - -	Louisville, Ky.
Hospodarska Listy - - -	Chicago, Ill.
Indiana Farmer - - - - -	Indianapolis, Ind.
Inland Farmer - - - - -	Louisville, Ky.
Iowa Agriculturist - - - -	Ames, Iowa.
Iowa Homestead - - - -	Des Moines, Iowa.
Journal of Agriculture - - -	St. Louis, Mo.
Kansas Farmer - - - -	Topeka, Kan.
Kimball's Dairy Farmer - - -	Waterloo, Iowa.
Live Stock and Dairy Journal -	Fresno, Cali.
Live Stock Journal - - - -	Chicago, Ill.
Live Stock Journal - - - -	Indianapolis, Ind.
Louisiana Planter - - - -	New Orleans, La.
Mennonitsche Rundschau - -	Elkhart, Ind.
Metropolitan Rural Home - - -	New York, N. Y.
Modern Farmer - - - -	St. Joseph, Mo.
National Farmer and Stock Grower -	St. Louis, Mo.
National Fruit Grower - - -	St. Joseph, Mo.
National Stockman and Farmer - -	Pittsburg, Pa.
Nebraska Farmer - - - -	Lincoln, Neb.
New England Farmer - - - -	Boston, Mass.
New York Produce Review - -	New York, N. Y.
New York Tribune Farmer - -	New York, N. Y.
North and South - - - -	Louisville, Ky.
North Western Agriculturist - -	Minneapolis, Minn.
Northwest Horticulturist - - -	Tacoma, Wash.
Ohio Farmer - - - - - -	Cleveland, O.
Orange Judd Farmer - - -	Chicago, Ill.
Operative Miller - - - - -	Chicago, Ill.
Oregon Agriculturist - - -	Portland, Ore.
Our Horticultural Visitor - - -	Benton Harbor, Mich.
Pacific Northwest - - - -	Portland, Ore.
Pacific Rural Press - - - -	San Francisco, Cali.
Practical Farmer - - - -	Philadelphia, Pa.
Practical Fruit Grower - - -	Springfield, Mo.

Prairie Farmer - - - -	Chicago, Ill.
Pure Products - - - - -	New York, N. Y.
Reliable Poultry Journal - - -	Quincy, Ill.
St. Louis Republic - - - -	St. Louis, Mo.
Shepherds' Criterion - - -	Chicago, Ill.
Southern Farm Magazine - - -	Baltimore, Md.
Southern Planter - - - -	Richmond, Va.
Southern States - - - - -	Baltimore, Md.
Strawberry Specialist - - -	Kittrell, N. C.
Successful Farming - - - -	Des Moines, Iowa.
Swine Breeders' Journal - - -	Indianapolis, Ind.
The Trade - - - - - -	Baltimore, Md.
The Feather - - - - -	Washington, D. C.
Tri-State Farmer - - - -	Chattanooga, Tenn.
Up to Date Farming - - - -	Indianapolis, Ind.
Wallace's Farmer - - - -	Des Moines, Ia.
Western Horseman - - - -	Indianapolis, Ind.
West Virginia Farm Review - -	Charlestown, W. Va.
Wisconsin Agriculturist - - -	Racine, Wis.
Wool Markets and Sheep - - -	Chicago, Ill.

GENERAL STATE PERIODICALS.

Advertiser - - - - - -	Medaryville, Ind.
American Standard - - - -	Frankfort, Ind.
Banner - - - - - -	Bluffton, Ind.
Columbia City Mail - - -	Columbia City, Ind.
Democrat - - - - - -	Salem, Ind.
Enterprise - - - - -	Wolcott, Ind.
Kendallville News - - - -	Kendallville, Ind.
Lafayette Commericial Gazette -	Lafayette, Ind.
Lyons Herald - - - - -	Lyons, Ind.
News - - - - - -	Monon, Ind.
Progress-Examiner - - - -	Orleans, Ind.
Public Press - - - - -	New Albany, Ind.
Recorder - - - - - -	Rising Sun, Ind.
Register - - - - - -	Crown Point, Ind.
Ripley Journal - - - - -	Osgood, Ind.

FOREIGN PERIODICALS.

Agricultural Gazette of N. S. Wales	Sidney, Australia.
Cooperative Farming - - - -	Sussex, N. B.
Farmers' Advocate - - - -	London, Ont.
Journal of Agriculture of Victoria -	Melbourne, Australia.

Natal Agricultural Journal and Mining Record - - - - - -	Natal, S. A.
Journal of the Royal Horticultural Society - - - - - -	London, England.
New Zealand Dairyman and Farmers' Union Journal - - - - -	Wellington, N. Z.
Station, Farm and Dairy - - - -	Sidney, N. S. W.
Transvaal Agricultural Journal - -	Pretoria, S. A.
Queensland Agricultural Journal - -	Brisbane, Australia.

LIST OF BULLETINS

Published by

The Indiana Agricultural Experiment Station,

To December 1, 1905.

Bulletins of the School of Agriculture.

*Bulletin No. 1, January, 1885, pp. 10, pl. II. The Hessian Fly. By F. M. Webster.

*Bulletin No. 2, January, 1885, pp12. Experiments with nitrogenous, phosphatic and other fertilizers. By W .C. Latta.

*Bulletin No. 3, April, 1885, pp. 8, pl. III. Insects affecting growing wheat. By F. M. Webster.

*Bulletin No. 4, September, 1885, pp. 12. Experiments with wheat. By W. C. Latta.

*Bulletin No. 5, November, 1885, pp. 12, pl. II. Experiments with small fruits. By James Troop.

*Bulletin No. 6, March, 1886, pp. 16. Experiments with oats and corn. By W. C. Latta.

*Bulletin No. 7, 1886, pp. 12. Commercial fertilizers and notes on agricultural chemistry. By R. B. Warder.

*Bulletin No. 8, August 24, 1886, pp. 16. Experiments with wheat. By W. C. Latta.

*Bulletin No. 9, October 30, 1886, pp. 8, pl. I. The American Meromyza. By F. M. Webster.

*Bulletin No. 10, December 15, 1886, pp. 8. Report of the Director of the Indiana State Horticultural Experiment Stations. By James Troop.

*Bulletin No 11, 1887, pp. 4. Commercial Fertilizers. By R. B. Warder.

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*Supply Exhausted.

*Bulletin No. 12, August 25, 1887, pp. 16. Experiments with wheat. By W. C. Latta.

Bulletins of the Purdue University Agricultural Experiment Station.

Bulletin No. 13, January, 1888, pp. 16. Report on new organization. By Pres. J. H. Smart.

Bulletin No. 14, April, 1888, pp. 20. Experiments with oats and corn. By W. C. Latta.

Bulletin No. 15, June, 1888, pp. 14, figs. 9. Concerning the potato tuber. By J. C. Arthur.

*Bulleting No. 16, August, 1888, pp. 12. Experiments with wheat. Crop rotation. By W. C. Latta.

Bulletin No. 17, November, 1888, pp. 4. Parturient apoplexy. By T. D. Hinebauch.

Bulletin No. 18, January, 1889, pp. 12, pl. I. Experiments with vegetables. By James Troop.

Bulletin No. 19. January, 1889, pp. 12, figs. 6. Spotting of peaches and cucumbers. By J. C. Arthur.

Bulletin No. 20, January, 1889, pp. 12, figs. 3, I. Experiments in cross fertilization. II. The culture of tropical ferns. By Pierre Van Landeghem.

Bulletin No. 21, February, 1889, pp. 16. How to feed rationally. By C. A. Wulff.

Bulletn No. 22, March, 1889, pp. 16. Commercial fertilizers. By H. A. Huston.

*Bulletin No. 23, April, 1889, pp. 12. Experiments with corn. By W. C. Latta.

*Bulletin No. 24, May, 1889, pp. 16, fig. I, pl. I. Experiments on milk production. By C. A. Wulff.

Bulletin No. 25, June, 1889, pp. 18, figs. 3. Entomological experiments. By F. M. Webster.

Bulletin No. 26, July, 1889, pp. 20, figs. 9. Wheat rust. By H. L. Bolley.

*Bulletin No. 27, August, 1889, pp. 12. Field experiments with wheat. By. W. C. Latta.

*Bulletin No. 28, September, 1889, pp. 24, figs. 7. Smut of wheat and oats. By J. C. Arthur.

*Bulletin No. 29, December, 1889, pp. 44, plates XIX. Grasses of Indiana. By James Troop.

*Bulletin No. 30, February, 1890, pp. 12, figs. 2. Influenza. By T. D. Hinebauch.

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*Supply Exhausted.

Bulletin No. 31, April, 1890, pp. 22, figs. 13. Experiments with small fruits and vegetables. By James Troop.

*Bulletin No. 32, July, 1890, pp. 22. (1) Treatment of smut in wheat, by J. C. Arthur. (2) Field experiments with wheat, By W. C. Latta. (3) A note on two inferior fertilizers. By C. S. Plumb.

*Bulletin No. 33, October, 1890, pp. 23-54, fig. 1. Small fruits, By James Troop. Entomological notes. By F. M. Webster. The absorptive power of soils, By H. A. Huston and Arthur Goss.

Bulletin No. 34, vol. II, February, 1891, pp. 55-80. (1) Sugar beets. By H. A. Huston. (2) Field experiments with commercial fertilizers and manure on barley and oats. By W. C. Latta. (3) Tests of vegetables. By James Troop.

*Bulletin No. 35, March, 1891, pp. 81-108, figs. 2-4. Loose smut of oats. By J. C. Arthur.

*Bulletin No. 36, vol. II, August, 1891, pp. 109-138. (1) Field experiments with wheat. (2) Testing grain. By W. C. Latta. (3) Wheat scab. By J. C. Arthur. (4) Forms of nitrogen for wheat. By H. A. Huston.

*Bulletin No. 37, vol. II, December, 1891, pp. 139-150, (1) Steer feeding. A comparison of cut with uncut clover. By C. S. Plumb. (2) Composition and valuation of Indiana feeding stuffs. By H. A. Huston.

*Bulletin No. 38, vol. III, March, 1892, pp. 29, plate I. (1) Small fruits. (2) Treatment of powdery mildew and black rot. (3) Vegetables. By James Troop.

*Bulletin No. 39, vol. III, April, 1892, pp. 31-62, plates II,III. (1) Field experiments with corn. By W. C. Latta. (2) Sugar beets. By H. A. Huston. (3) Diseases of the sugar beet root. By J. C. Arthur.

Bulletin No. 40, vol. III, June, 1892, pp. 63-82, fig. 1. The silo and silage in Indiana. By C. S. Plumb.

Bulletin No. 41, vol. III, August, 1892, pp. 83-102. (1) Field experiments with wheat. By W. C. Latta. (2) Forms of nitrogen for wheat. By H. A. Huston.

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*Supply Exhausted.

*Bulletin No. 42, vol. III, November, 1892, pp. 103-118, figs. 4. The potato: The relation of number of eyes on the seed tuber to the product. By J. C. Arthur.

*Bulletin No. 43, vol. IV, March, 1893, pp. 20. (a) Field experiments with corn. By W. C. Latta. (b) The sugar beet in Indiana. By H. A. Huston.

*Bulletin No. 44, vol. IV, May, 1893, pp. 21-44, figs. 4. Dairy experiments. By C. S. Plumb.

*Bulletin No. 45, vol. IV, August, 1893, pp. 45-65. Field experiments with wheat. By W. C. Latta. Forms of nitrogen for wheat. By H. A. Huston.

Bulletin No. 46, vol. IV, September, 1893, pp. 66-85, fig. 1. (1) A modification of Grandeau's method for the determination of humus. (2) Preliminary investigation relating to the determination of "crude fibre." By H. A. Huston and W. F. McBride.

*Bulletin No. 47, vol. IV, November, 1893, pp. 86-101, figs. 2. (1) Does it pay to shelter milch cows in winter? (2) Upon skim milk as a food for calves. By C. S. Plumb.

*Bulletin No. 48, vol. V, January, 1894, pp. 14. Experiments with small fruits. By James Troop.

*Bulletin No. 49, vol. V, March, 1894, pp. 15-40, figs. 3. Sugar beets. By H. A. Huston.

*Bulletin No. 50, vol. V, April, 1894, pp. 41-56. Field experiments with corn and oats. By W. C. Latta.

*Bulletin No. 51, August, 1894, pp. 57-80. (1) Field experiments with wheat. By W. C. Latta and Geo. R. Ives. (2) Forms of nitrogen for wheat. By H. A. Huston.

*Bulletin No. 52, vol. V, November, 1894, pp. 81-113, figs. 4, plates IV. Wild or prickly lettuce. By J. C. Arthur.

*Bulletin No. 53, vol. V, December, 1894, pp. 115-130, figs. 7, plates V, VI. Horticulture and entomology. By James Troop.

*Bulletin No. 54, vol. VI, February, 1895, pp. 8, plates II, fig. 1. New chemical apparatus. By H. A. Huston.

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*Supply Exhausted.

Bulletin No. 55, vol. VI, March, 1895, pp. 9-56, fig. 1. Experiments with small fruits. By James Troop. Experiments with corn and oats. By W. C. Latta and George R. Ives.

Bulletin No. 56, vol. VI, August, 1895, pp. 57-80. Field experiments with wheat. By W. C. Latta and S. P. Carithers. Potato scab and its prevention. By J. C. Arthur.

*Bulletin No. 57, vol. VI. November, 1895, pp. 81-100, figs, 2-6, plates III-IV. The improvement of unproductive black soil. By. H. A. Huston.

*Bulletin No. 58, vol. VII, February, 1896, pp. 10. Hog cholera and swine plague in Indiana. By A. W. Bitting.

Bulletin No. 59, vol. VII, 1896, pp. 11-40, plates VIII, figs. 24. Bacteriosis of Carnations. By. J. C. Arthur and H. L. Bolley.

*Bulletin No. 60, vol. VII, April, 1896, pp. 41-54, plates IX-XIV, figs. 25-31. The American persimmon. By James Troop and O. M. Hadley.

*Bulletin No. 61, vol. VII, August, 1896, pp. 55-70. Field experiments with wheat. By W. C. Latta and W. B. Anderson.

*Bulletin No. 62, vol. VII, October, 1896, pp. 71-96, figs. 32-42. The udder of the cow. By C. S. Plumb.

*Bulletin No. 63, vol. VII, December, 1896, pp. 97-116, plates XV-XVI. Bovine tuberculosis in Indiana. By A. W. Bitting.

Bulletin No. 64, vol. VIII, April, 1897, pp. 16. Field experiments with corn, oats and forage plants. By W. C. Latta and W. B. Anderson.

Bulletin No. 65, vol. VIII, June, 1897, pp. 17-36, plates II. Formalin for prevention of potato scab. By J. C. Arthur.

Bulletin No. 66, vol. VIII, October, 1897, pp. 37-60, plates III and IV, fig. 1. Indoor lettuce culture. By William Stuart. Condensed edition also, 8 pp.

*Bulletin No. 67, vol. VIII, December, 1897, pp. 61-70. Wheat and corn as food for pigs. C. S. Plumb and W. B. Anderson.

Bulletin No. 68, vol. IX, March, 1898, pp. 32, figs. 13. The sugar beet in Indiana. By H. A. Huston and J. M. Barrett.

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*Supply Exhausted.

Bulletin No. 69, vol. IX, March, 1898, pp. 33-40. Insecticides, fungicides and spraying. By James Troop.

Bulletin No. 70, vol. IX, 1898, pp. 41-52, figs. 14-16. The relation of water supply to animal diseases. By A. W. Bitting.

Bulletin No. 71, vol. IX, June, 1898, pp. 53-64. I. Corn meal and shorts as food for pigs. By C. S. Plumb and S. B. Anderson. II. Skim-milk as food for young chickens. By W. B. Anderson.

Bulletin No. 72, vol. IX, August, 1898, pp. 65-76. Field experiments with wheat. By W. C. Latta and W. B. Anderson.

Bulletin No. 73, vol. IX, October, 1898, pp. 77-92, figs. 17-19. Tests of strawberries, raspberries, blackberries, grapes. By James Troop.

Bulletin No. 74. vol. IX, November, 1898, pp. 93-100, figs. 20, plates I-VI. A native white bedding plant. By J. C. Arthur.

Bulletin No. 75, vol. X,. January, 1899, pp. 1-20, fig. 1. The sugar beet in Indiana in 1898. By H. A. Huston and A. H. Bryan.

*Bulletin No. 76, vol. X, March, 1899, pp. 21-28. Skim milk as a food for young growing chickens. By W. B. Anderson.

Bulletin No. 77, vol. X, March, 1899, pp. 29-44. Field experiments with corn. By W. C. Latta and W. B. Anderson.

Bulletin No. 78, vol. X, May, 1899, pp. 45-52. Figs. 2-4. The San Jose and other scale insects, and the Indiana nursery inspection law. By James Troop.

Bulletin No. 79, vol. X, June, 1899, pp. 53-62. Roots as food for pigs. By C. S. Plumb and H. E. Van Norman.

Bulletin No. 80, vol. X, September, 1899, pp. 63-76, figs. 5-12. Sheep scab. By A. W. Bitting.

Bulletin No. 81, vol. X, December, 1899, pp. 77-92. Field tests with fertilizers on heavy clay lands. By. H. A. Huston.

Bulletin No. 82, vol. X, March, 1900, pp. 93-106. Roots and other succulent foods for swine. By. C. S. Plumb.

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*Supply Exhausted.

Bulletin No. 83, vol. X, August, 1900, pp. 107-114. Test of small fruits. By James Troop.

Bulletin No. 84, vol. X, September, 1900, pp. 115-142, plates III, graphic charts III. Growing lettuce with chemical fertilizers. By William Stuart.

Bulletin No. 85, vol. X, October, 1900, pp. 143-150. Chrysanthemum rust. By. J. C. Arthur.

Bulletin No. 86, vol. X, December, 1900, pp. 151-158. On the amount of water in slop fed fattening pigs. By C. S. Plumb and H. E. Van Norman.

Bulletin No. 87, vol. XI, March, 1901, pp. 1-26. Formalin as a preventative of oats smut. By William Stuart.

Bulletin No. 88, vol. XI, May, 1901, pp. 27-38. Systems of cropping with and without fertilization. By W. C. Latta and J. H. Skinner.

Bulletin No. 89, vol. XI, July, 1901, pp. 39-69. The production and delivery of milk in cities. By A. W. Bitting.

Bulletin No. 90, vol. XI, October, 1901, pp. 70-82. Tankage as a food for pigs. By C. S. Plumb and H. E. Van Norman.

Bulletin No. 91, vol. XI, January, 1902, pp. 83-106. Fig. 2-5. The modern silo. By C. S. Plumb.

Bulletin No. 92, vol. XI. April, 1902, pp. 101-116. Fertilizer tests on tomatoes. By H. A. Huston.

Bulletin No. 93, vol. XI, June, 1902, pp. 117-123. The influence of condimental stock food in fattening swine. By. C. S. Plumb.

Bulletin No. 94, vol. XII, February, 1903, pp. 1-88. Illustrations 15. Diseases of sheep. By A. W. Biting and R. A. Craig.

Bulletin No. 95, vol. XII, March, 1903, pp. 1-31, Plates I-IV, Figs. 1-5. The improvement of unproductive black soils. By H. A. Huston.

Bulletin No. 96, vol. XII, July, 1903, pp. 1-36. Figs. 1-8. The care of milk and butter making on the farm. By H. E. Van Norman.

Bulletin No. 97, vol. XII, October, 1903, pp. 37-42. On the value of distillery dried grains as a food for work horses. By C. S. Plumb.

Bulletin No. 98, vol. XII. January, 1904, pp. 43-56. Fig. 1, plates I-VI. Three edible toadstools. By J. C. Arthur.

Bulletin No. 99, vol. XII, March, 1904, pp. 57-68. Tests of small fruits. By James Troop.

Bulletin No. 100, vol. XII, September, 1904, pp. 69-204. Illustrations 23. Diseases of swine. By. R. A. Craig and A. W. Bitting.

Bulletin No. 101, vol. XII, February, 1905, pp. 205-219. Alfalfa in Indiana. By A. T. Wiancko and M. L. Fisher.

Bulletin No. 102, vol. XII, March, 1905. pp. 220-254. Illustrations 8. Apple growing in Indiana. By J. Troop.

Bulletin No. 103, vol. XII. March, 1905. pp. 255-264 . Rapid method of removing smut from seed oats. By J. C. Arthur.

*Bulletin No. 104, vol. XII, March, 1905. pp. 265-274. Illustrations 2. A simple alkali test for ripeness of cream. By H. E. Van Norman.

Bulletin No. 105, vol. XII. March, 1905. pp. 275-322. Illustrations 14. Corn improvement in Indiana. By A. T. Wiancko.

Bulletin No. 106, vol. XII. May, 1905. pp. 52. Maps 1. Commercial fertilizers. By Arthur Goss and W. J. Jones, Jr.

Bulletin No. 107, vol. XIII. July, 1905, pp. 12. Agriculture at Purdue University. By Pres. W. E. Stone.

Bulletin No. 108, vol. XIII, July, 1905. pp. 13-32. Illustrations 4. Soy beans, middlings and tankage, as supplemental feeds in pork production. By J. H. Skinner.

Bulletin No. 109, vol. XIII, November, 1905. pp. 33-76. Illustrations 28. Examination of horses for soundness. By A. W. Bitting and G. H. Roberts.

FINANCIAL STATEMENT.

Treasurer's Report.

Receipts for Experiment Station Funds:

Balance from Miscellaneous fund, June 30, 1904 -	$ 1,052 73
From United States Treasurer, for year ending June 30, 1905 - - - - - - - - - -	15,000 00
From State Treasurer, for year ending Oct. 31, 1905 -	5,000 00
From Miscellaneous receipts, for year ending June 30, 1905- - - - - - - - - -	10,828 05
Total - - - - - - - - -	$ 31,880 78

James M. Fowler,
Treasurer Board of Trustees.

Secretary's Report.

Government or Hatch Fund, for the Year Ending June 30, 1905.

	Dr.	Cr,
Received from U. S. Treasurer - -	$15,000 00	
Salaries - - - - - - - -		$ 7,901 62
Labor - - - - - - - -		1,525 15
Publications - - - - - - -		2,616 05
Postage and stationery - - -		420 25
Freight and express - - - - -		74 93
Heat, light, water and power - -		32 00
Chemical supplies - - - - - -		883 78
Seeds, plants, and sundry supplies -		386 89
Fertilizers - - - - - - - -		0 00
Feeding stuffs - - - - -		0 00
Library - - - - - - - -		230 47
Tools, implements and machinery -		192 45
Furniture and fixtures - - - - -		242 00
Scientific apparatus - - - -		100 28
Live stock - - - - - - -		0 00
Traveling expenses - - - -		203 05
Contingent expenses - - - - -		15 00
Buildings and repairs - - - -		176 08
Total - - - - - -	$15,000 00	$15,000 00

State Funds, for the Year Ending October 31, 1905.

	Dr.	Cr.	
Received from State Treasurer	$ 5,000 00		
General.			
Publications - - - -		$ 133 75	
Printing, stationery and postage		49 00	
Sundry supplies - - -		1 35	
Traveling Expenses - -		54 73	
Buildings and repairs - -		617 50	
Live Stock Feeding.			$ 856 33
Salary, assistant - - -		166 66	
Printing, stationery and postage		9 00	
Feeding stuffs - - -		152 56	
Traveling expenses - - -		6 43	
Contingent expenses, principally telegrams and telephones -		62	
Buildings and improvements		545 38	
Dairy Interests.			$ 880 65
Salaries, assistants - -		$ 644 97	
Labor - - - - - -		96 85	
Printing, stationery and postage		20 05	
Express and freight - - -		11 27	
Sundry supplies - - -		20 47	
Tools, new - - - -		24 71	
Traveling expenses - -		340 99	
Contingent expenses, principally telegrams and telephones -		2 30	
Crop and Soil Improvement.			$ 1,161 61
Salaries, assistants - -		$ 983 85	
Labor - - - - - -		45 00	
Publications - - -		2 50	
Printing, stationery and postage		24 50	
Express and freight - -		177 02	
Sundry supplies - - -		214 27	
Fertilizers - - - -		195 00	
Tools, new - - - -		2 75	
Furniture and fixtures - -		26 00	
Traveling expenses - - -		423 47	
Contingent expenses, principally telegrams and telephones -		7 05	$ 2,101 41
Total - - - - -	$ 5,000 00		$ 5,000 00

Miscellaneous Fund, For the Year Ending June 30, 1905
(Derived from farm sales, fertilizer inspection fee, etc.)

	Dr.	Cr.
Balance June 30, 1904 - - - -	$ 1,052 73	
Total receipts - - - - - -	10,828 05	
Salaries - - - - - - - -		$ 4,429 10
Labor - - - - - - - - -		761 97
Publications - - - - - - -		184 35
Postage and stationery - - - - -		925 33
Freight and express - - - - -		90 58
Heat, light, water and power - - -		210 54
Chemical supplies - - - - -		333 76
Seeds, plants and sundry supplies - -		666 50
Fertilizers - - - - - - - -		0 00
Feeding stuffs - - - - - - -		0 00
Library - - - - - - - -		4 00
Tools, implements and machinery - -		160 70
Furniture and fixtures - - - - -		0 00
Scientific apparatus - - - - - -		3 25
Live stock - - - - - - - -		8 00
Traveling expenses - - - - - -		796 58
Contingent expenses - - - - -		0 00
Buildings and repairs - - - - -		0 00
Balance - - - - - - - -		3,306 12
Total - - - - - - - -	$11,880 78	$11,880 78

Summary of Total Receipts and Expenditures of the Station.

Hatch and Miscellaneous Funds for the Year Ending June 30, 1905; State Funds for the Year Ending October 31, 1905.

	Dr.	Cr.
Balance from year previous	$ 1,052 73	
Rec'd from U. S. Gov., Hatch fund	15,000 00	
Rec'd from State, Agricultural Experiment fund	5,000 00	
Other receipts, Miscellaneous fund	10,828 05	
Salaries		$14,126 20
Labor		2,428 97
Publications		2,936 65
Postage and stationery		1,448 13
Freight and express		353 80
Heat, light, water and power		242 54
Chemical supplies		1,217 54
Seeds, plants and sundry supplies		1,289 48
Fertilizers		195 00
Feeding stuffs		152 56
Library		234 47
Tools, implements and machinery		380 61
Furniture and fixtures		268 00
Scientific apparatus		103 53
Live stock		8 00
Traveling expenses		1,825 25
Contingent expenses		24 97
Buildings and repairs		1,338 96
Balance		3,306 12
Total	$31,880 78	$31,880 78

The foregoing is a correct statement of expenditures from the Hatch and Miscellaneous funds for the year ending June 30, 1905, and from the State funds for the year ending October 31, 1905.

Edward A. Ellsworth,
Secretary Board of Trustees.

PURDUE UNIVERSITY

Nineteenth Annual Report

OF THE

Agricultural Experiment Station

LAFAYETTE, INDIANA

For the Year Ending June 30, 1906

LAFAYETTE, IND.
PRESS OF BURT-TERRY-WILSON CO.
1906

PURDUE UNIVERSITY

Nineteenth Annual Report

OF THE

Agricultural Experiment Station

LAFAYETTE, INDIANA

For the Year Ending June 30, 1906

LAFAYETTE, IND.
PRESS OF BURT-TERRY-WILSON CO.
1906

TO THE GOVERNOR:

I transmit herewith the annual report of the Purdue University Agricultural Experiment Station for the year ending June 30, 1906.

WILLIAM V. STUART,
President of the Board of Trustees.

December 1, 1906.

TO THE PRESIDENT OF THE BOARD OF TRUSTEES:

I herewith present the nineteenth annual report of the Agricultural Experiment Station of Indiana for the year ending June 30, 1906, the same being required by Section 3, of an act entitled "An act to establish Agricultural Experiment Stations in connection with the Colleges established in the several States, under provisions of an act approved July, 1862, and of the acts supplemental thereto," and being in accordance also with the instructions of the Department of Agriculture.

This report consists of a report of the Director of the Station, a summary of Station investigations by members of the Staff, a list of the Station bulletins published prior to December 1, 1906, and a financial report of the Secretary of the Board of Trustees.

WINTHROP E. STONE,
President.

December 1, 1906.

BOARD OF CONTROL.

William V. Stuart, President,	LaFayette, Tippecanoe County
Sylvester Johnson,	Irvington, Marion County
David E. Beem,	Spencer, Owen County
Henry A. Miller,	Montmorenci, Tippecanoe County
James M. Barrett,	Fort Wayne, Allen County
Charles Downing,	Greenfield, Hancock County
Joseph D. Oliver,	South Bend, St. Joseph County
Charles Major,	Shelbyville, Shelby County
Addison C. Harris,	Indianapolis, Marion County

Winthrop E. Stone, A. M., Ph. D., - President of the University

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STATION STAFF.

Arthur Goss, M.S., A.C.	Director, Station Chemist, State Chemist
William C. Latta, M. S.,	Consulting Agriculturist
James Troop, M. S.,	Horticulturist and Entomologist
Joseph C. Arthur, D. Sc.,	Botanist
John H. Skinner, B. S.,	Animal Husbandry
Alfred T. Wiancko, B. S. A.,	Agriculturist
Robert A. Craig, D. V. M.,	Veterinarian
Otto F. Hunziker, M. S. A.,	Dairy Husbandry
William J. Jones, Jr., M. S., A. C.,*	Associate Chemist
Martin L. Fisher, B. S.,	Assistant Agriculturist
Samuel D. Conner, B. S.,	Assistant Chemist
Owen C. Haworth, B. S.,*	Assistant Chemist
Frank D. Kern, B. S.,	Assistant Botanist
George I. Christie, B. S. A.,	Associate Agri. Extension Work
Wilber A. Cochel, A. B., B. S.,	Assistant in Animal Husbandry
Walter P. Kelley, B. S.,	Assistant in Soil Improvement
Lawrence S. Hasselman, B. S.,	Assistant Chemist
Clinton O. Cromer, B. S.,	Assistant Agriculturist
Charles G. Woodbury, M. S.,	Assistant Horticulturist
Herman D. Wendt,	Dairy Field Assistant
Roland E. Stone,	Assistant Botanist
Madison B. Porch, B. S.,*	Assistant Chemist
Nellie Tracy,	Clerk and Librarian
Jessie L. Cowing,	Bookkeeper

*Connected with Fertilizer Control.

ADVISORY COMMITTEE.

UNDER LEGISLATIVE ACT OF 1905.

D. F. Maish, Frankfort, State Corn Growers' Association.
W. R. Pleak, Greensburg, State Live Stock Association.
Samuel Schlosser, Plymouth, State Dairy Association.

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NINETEENTH ANNUAL REPORT

OF THE

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION.

FOR THE YEAR ENDING JUNE 30, 1906.

TO PRESIDENT W. E. STONE:

Sir:—I take pleasure in submitting herewith the Nineteenth Annual Report of the Indiana Agricultural Experiment Station. This includes the report of the Director, a summary of the work of the different departments, a list of periodicals received, a list of all bulletins published prior to December 1, 1906, a financial statement of the receipts and expenditures from the Hatch and Miscellaneous funds for the year ending June 30, 1906, and a financial statement of the State Agricultural Experiment fund for the year ending October 31, 1906.

Very respectfully,
ARTHUR GOSS,
Director.

Report of the Director.

The work of the Station has been increasing so rapidly during the last two or three years, that it is difficult for any one not directly connected with Station affairs to realize the scope of its increased activity. For this reason a brief summary of the work in general may not be out of place at this time. A detailed account of the work of the different departments for the year ending June 30, 1906, will be found elsewhere.

Financial Condition.

The marked expansion in the activities of the Station has been brought about by a number of causes, chief among which perhaps is the considerable increase in funds for carrying on the work.

Prior to July, 1904, the entire revenue of the Station was the Government Hatch fund of $15,000.00 annually, and an additional

thousand or two derived from the sale of farm products and other miscellaneous sources. This meagre endowment had to suffice for paying all expenses in connection with the scientific work of the Station and for the management and running of the University farm as well. This latter, involving as it did the purchase of feeding stuffs for the stock kept, was no small item, and cut into the revenues very materially. Such a state of affairs meant of course, that there could be no expansion, or even normal growth. Every department was in urgent need of assistance and the only wonder is that so much excellent work was accomplished under such adverse conditions.

In July, 1904, the tide of financial prosperity having apparently receded to its utmost outward limit, turned, and has since been making in the direction of the Station. The first forward wave was the action of the Board of Trustees of the University in relieving the Station of the burden of managing the farm, by placing the same, with the exception of the portion used for permanent experiments, under the management of the University. The next wave was the action of the Board in placing the administration and revenues of the fertilizer control work under Station instead of University control as had been the case in the past. The above changes resulted in increasing the funds of the Station several thousand dollars annually. Then came the state appropriation whereby the income of the Station along certain specified lines was increased $25,000.00 annually. The next succeeding and most recent addition was the Adams appropriation by the Federal Government, which will ultimately result in an increase of $15,000.00 annually in the funds of the Station.

Additions to Working Force and Equipment.

As a result of the above increase in funds, it has been possible to strengthen the work of the Station in almost all departments, by adding to the working force. Thus, in the Agricultural department, the State Soil and Crop Improvement fund has made possible the addition of two men to the force and a very decided expansion in the work, especially in the line of cooperative experiments. In the Chemical department, the same appropriation has made possible the addition of a man to look after the field fertilizer test work, contemplated in the act. In the Animal Husbandry department, the State Live Stock Feeding fund has made possible the addition of an assistant to look after the feeding experiments provided for by the law. In the Dairy department the state appropriation has also made possible a very material expansion in the work, which has been accompanied by the addition of two new men. In the Botanical and

Horticultural departments, the addition of much needed assistants has also been made possible.

Since the state appropriation became available it has also been possible to strengthen nearly every department in the way of material equipment by the addition of apparatus, office furniture, general supplies, etc. In connection with the live stock feeding work, feeding sheds have been erected at a cost of several hundrd dollars. The library has been decidedly improved recently by the addition of new books, reports and periodicals, and by the construction of cases for the accommodation of the same. The bulletins and reports from the different stations and the U. S. Department of Agriculture have been bound up to date, and the entire library material has been gone over and placed on a good working basis. As the room formerly occupied by the library became too small to accommodate the work, a larger room was set apart for this purpose and the equipment moved into it. While the library equipment is still very far from complete, a good start has been made and it is hoped to materially add to the collection of books and reports as rapidly as funds and opportunity will permit.

Importance of the Work of the Station.

The question will naturally arise, has the work of the Station kept pace with the increase in funds and equipment, and has it been a good business proposition for the State and Government to invest such considerable sums of money in this kind of work? While space will not permit of a detailed discussion of this question at this time, it may be well to mention briefly some of the work being carried on and attempt to indicate what the same should mean to the farmers of the state.

The most important branch of the Station activities of course is the experimental work. While comparatively little is said or known about this class of work, outside of the departments where such investigations are being conducted, it never-the-less forms a very essential part of the Station activities, and furnishes the foundation for the facts that are presented to the public. This class of work necessarily requires much time, and not infrequently results in failure, but occasionally a problem is solved that amply repays for all the time and effort spent, not only on that investigation but on many others as well.

Research experimental work is being carried on in many departments of the Station, almost the entire time of the working force of some of them being devoted to this class of work.

Thus in the Veterinary Department at the present time an investigation is being conducted concerning hog cholera. This same

work has been in progress, in different phases, in this department for several years, and while up to the present time no satisfactory remedy has been discovered for this extremely fatal swine disease, much has been learned concerning its distribution, method of transmission, character, etc., that may very materially aid some other investigator in working out a remedy, even if this Station is not so fortunate as to do so.

In the Agricultural Department many important investigations are in progress, such as the crop improvement work involving the breeding and selection of best types of corn, wheat, etc., the study of the effect of different methods of planting and cultivation, the testing of the applicability of new crops such as alfalfa, the study of varieties of the principal crops grown in the state and the investigation of the effect of different systems of crop rotation. Several of these investigations have been in progress for more than 20 years. Such investigations are yielding results that will undoubtedly be of the highest value to the farmers of the state.

The importance of such work in connection with the wheat crop is indicated by the following figures: The average yield of wheat under field conditions and without fertilization, on the Station farm for the past 20 years, is just about 30 bushels per acre. The average yield for the state for the same period is 13.9 bushels per acre. The average yield for the county in which the Station farm is located for the same period is 14.1 bushels per acre, and the average yield for the best wheat county in the state for the same time is only 15.7 bushels per acre, or very lttle more than half the yield on the Station farm. Now, while the land of the Station farm may be somewhat better adapted to wheat culture than the average land of the best wheat county in the state, (although this assumption is somewhat doubtful), it certainly is not as much better as indicated by the difference in yields. The principal part of the increase on the Station farm is undoubtedly due to the application of better methods. As it has been possible by means of expert knowledge to secure such a large increase in the yield of wheat on the Station farm over other good wheat sections of the state, it would seem entirely feasible through the application of similar methods, to increase the average yield of wheat in the entire state a number of bushels per acre. As the average annual acreage of wheat in the state is about 2,330,900 acres, the increase of but a single bushel per acre would pay for the entire cost of the Station many times over, and what is true of the wheat crop is also equally true of the other leading crops of the state.

That the above possibility of increasing the yield of wheat in the state is not mere visionary speculation is further indicated by a comparison of the yield in this state with the yields in some of the

European countries, where the proper cultural methods are better understood by the farmers in general. Thus, as stated above, the average yield of the state for the past 20 years is 13.9 bushels per acre. The average yield of Germany for a similar period is 27.2 bushels per acre and of Great Britain 31.6 bushels per acre.

When our farmers come to a fuller realization of the importance of the above facts and are able to take advantage of the knowledge at hand, there will be less waste of labor and land in the state, and the production of more grain and profit.

The work in breeding and selection in the case of the corn crop is also a very important matter as is indicated by the following: In this work the actual yields from different individual seed ears of the same variety and same general appearance, and having had exactly the same treatment, have varied from 65 to 127 bushels per acre. This being the case it would certainly seem worth while through careful selection and breeding to attempt to perpetuate the higher yielding strain. That such a thing is feasible is indicated by the fact that the average yield of six breeding plats, that have been carried on in different parts of the state for the past three years has been 78 bushels per acre against a considerably less yield for the general field crop. In one case this season where the specially bred seed was compared with seed of the original corn in alternate rows in the same field, there was an average difference of 8.7 bushels per acre in favor of the specially bred corn. As the average annual acreage of corn in the state for the past ten years was 4,069,710 acres, it will be seen that an increase in yield of even one bushel per acre would mean a considerable addition to the wealth of the state.

In the Chemical Department, among other things, tests of different fertilizers have been conducted in a number of places in the state for several years past. These tests have been considerably increased since the recent state appropriation. During this season such tests have been made with corn, wheat, oats, potatoes, onions, melons, fruit trees, etc., in over 50 places in the state.

As a broad general result of this work, it may be said that while occasionally a soil is found that does not respond readily to fertilizers, as a rule some combination has been found that has produced very profitable financial returns and not infrequently enormous profits. As an example, in this connection, may be mentioned a test of corn on clay soil, in Jennings county last season where the yield was increased over 26 bushels per acre from the use of $1.47 worth of fertilizer per acre. In a similar test on clay soil in Scott county the yield of wheat was increased over 26 bushels to the acre in a single season by the use of $3.20 worth of fertilizer. On muck soil in Starke county the yield of potatoes was increased 134 bushels

per acre this season from the use of $9.00 worth of fertilizer, and on muck soil in Kosciusko county, the yield of onions was increased over 180 bushels per acre by the use of $15.00 worth of fertilizer. These are but a few examples of what has been done; many more of a similar character could be cited.

In order that it may be seen just what such tests mean to the farmers of the state, mention will be made of an experiment in the fertilization of corn on muck soil in Newton county that has been carried on for the past three years. This experiment was started primarily to ascertain how long the effect of different fertilizers will last on this kind of soil. With this end in view heavy applications of the various fertilizers under test were made the first season, none being applied afterwards. Arrangements were made for harvesting the crops for a number of years. The present crop just harvested, is the third in the series, all three having been corn. One of the most notable features of the test is the fact that in practically all cases the results this year, the third season after the fertilizers were applied, were greater than during any other year of the test, although decided increases were secured the first and second seasons. The plats were just as distinctly marked this season as during the first season, showing that there had been very little lateral movement of the fertilizer, and judging from the results there would also seem to have been little loss.

It is to the financial phase of the question, however, that I wish to particularly call attention. The plat receiving 207 pounds of muriate of potash per acre has shown an aggregate increase in three years over the average of the four unfertilized plats in the series of 63.9 bushels of corn per acre,while the plat receiving practically the same amount of sulfate of potash has produced an increase of over 70 bushels per acre. Taking the smaller figure, the 63.9 bushels increase from the muriate, was worth, counting corn at 40 cents per bushel, $25.56. The fertilizer cost at current prices $5.18. Allowing the odd 38 cents for the cost of application we have a net profit during the three years from the use of the 207 pounds of muriate of potash of $20.00 per acre.

Attempts have been made elsewhere in this report to point out the possible financial benefits likely to result from experiments or investigations of the Station when applied to the whole state or country. It may be said that this might not mean much to individual farmers. Let us see what the facts are in the present case.

There are over 3,000 acres of muck soil on the farm where the above test is being conducted similar to that upon which the test is being made. An increase of $20.00 per acre over this area would mean a total of $60,000.00 or $20,000.00 annually on this one farm alone. This is four-fifths as much as the entire state ap-

propriation to the Station, and four times as much as was appropriated for all the soil and crop work.

It may be said that the above is not an isolated case by any means. Equally striking results have been secured from the use of potash on muck soils a number of times and in a number of places in the state.

In the Animal Husbandry Department, the principal part of the work at the present time is devoted to investigations concerning the feeding of farm animals. A very large development in this important branch of the Station work was made possible by the recent state appropriation for this specific purpose. In this connection the first systematic steer feeding experiment in the history of the Station was recently brought to a successful conclusion and the results secured have just been published in bulletin form. In order to give some idea of the importance of such work to the farmers of the state, it may be well to mention briefly some of the results secured in this experiment and point out their financial significance.

The experiment consisted of a comparison of three groups of feeds available to Indiana farmers, the first consisting of corn and clover hay, the second of corn, corn fodder, (stover), oat straw and about a pound and a half of oil meal per animal each day, and the third the same as the second, with the omission of the oil meal.

Thirty-three animals were purchased for the experiment on the Chicago market and divided into three as nearly uniform lots as possible, each lot being fed for 180 days. As a result of the experiment it was found that the first lot made a total average gain of 374 pounds per animal fed, the second lot 322 pounds and the third lot 234 pounds. Thus the lot receiving corn and clover hay made a gain of 140 pounds per animal more than the lot receiving corn, fodder and straw and the lot receiving a pound and a half of oil meal in addition to the corn, fodder and straw, made a gain of 88 pounds per animal more than the latter. Furthermore the animals in the lots receiving clover and oil meal sold on the open market at the end of the experiment for 35 cents per hundred more than the animals in the lots receiving corn, fodder and straw, as they were much smoother and better finished generally. Counting feed, beef, etc., at current prices, lot 1 made an average gain per animal of $8.62, lot 2 of $4.11, and lot 3 of $1.14, or a difference of $7.14 between the lot receiving corn and clover, and the lot receiving corn, fodder and straw.

While it is difficult to secure reliable figures in regard to the exact number of cattle fed in the state each season it is perhaps a conservative estimate to say that this number is not less than 60,000, and as such an experiment as the above shows that it is possible to make a difference in profit of several dollars per head by a slight

difference in the composition of the ration, it can readily be seen that such experiments should result in the saving of a large amount of money to the feeders of the state, certainly many times more than the amount invested in the feeding work of the Station.

In the Dairy Department an investigation concerning the loss of butter in different methods of separating cream from milk has just been completed and published in bulletin form that should be of much benefit to the farmers of the state and particularly to the farmers' wives.

As a result of this investigation it was found that the average loss of butter fat, and the average value of the same, for one cow for one year, by the four different methods of removing the cream indicated below was as follows:

	Butter fat lost lbs.	Value of butter fat lost. $
Hand separator	2.75	.63
Deep setting	17.34	3.99
Shallow pan	25.50	5.86
Water dilution	29.07	6.68

Thus, there is shown to be an average difference of $6.05 per cow per year between the hand separator and water dilution methods and of $5.23 between the hand separator and shallow pan methods. As the hand separator only costs from $60.00 to $75.00, it will be seen that the saving in butter in the case of any one milking several cows would pay for the machine in a short time, after which the butter saved would be clear profit. Even in the case of deep and shallow setting, this investigation shows the former to be more economical than the latter, and more common method, to the extent of $1.87 per annum for each cow. Now as there are about 668,000 dairy cows in the state, $1.87 on each cow would represent the very large sum of $1,249,160 that might be saved or lost each year, by using one or the other of these methods. It would seem that experiments indicating the means of saving such sums of money should certainly be well worth conducting and should pay for the amount put into them a great many times over.

In the Horticultural Department a large amount of valuable work has been done in testing the effect of different insecticides in preventing the ravages of insects affecting the orchards of the state. For a number of years past, much work has also been done in this department in testing different varieties of fruit. In this connection promising new varieties of strawberries and grapes have been originated.

In the Botanical Department the work for some time past has been devoted almost entirely to a study of the plant rusts, particular-

ly those affecting the grains, with a view to the discovery if possible of a remedy for wheat rust. While as yet no practical means of controlling this destructive disease has been discovered, much has been learned concerning its distribution, life history and habits, that may ultimately lead to practical results. Two similar investigations in this department have already produced practical results of the highest value. I refer to the remedies for potato scab and oat smut that were originated here. As a result of these investigations it is now possible to completely control these two very troublesome diseases.

Careful estimates have shown on the average that about eight per cent of the oats grown in the United States are destroyed by smut. Practically all of this loss might be prevented by treating the seed with a solution of formalin at an expense, when conducted on a large scale, of not to exceed one-half cent per bushel, or when done at home in a small way, of less than one and a half cents per bushel, or not to exceed five cents per acre.

The average annual value of the oats crop in this state for the 10 years closing with 1900, was $7,458,682. A saving of but one per cent of this amount would mean a gain to the farmers of the state each year of over $74,000.00, or more than the cost of the entire work of the Experiment Station.

The annual increase in wealth of the farming community, that might be brought about in the entire United States as a result of this investigation, is represented by the enormous sum of over $17,000,000.00, which is eight per cent of the total value of the oats crop, and it must further be borne in mind that the value of such a research does not end with the confines of the United States, but extends to practically every other country where oats are grown.

We know of no other field for investment that offers such immense returns on the amount invested as is offered by investment in Agricultural Experiment Station work.

These matters have been published several times in bulletin form, but as yet their importance is very imperfectly understood by our farmers. It would seem that important matters of this sort should be more frequently discussed by the institute workers and others.

It is such fundamental investigations as these that really count for most in the last analysis of the Station work, notwithstanding the fact that they are often slow, tedious, time-consuming operations that are too liable to be passed by as uninteresting or unimportant. If it were not for such basic research work the value of the Station work would soon cease to a very large extent, and agricultural progress would be very materially retarded.

Extension Work.

Another phase of the Station work is what may be called projection or extension work. While perhaps not so fundamental as the basic research work it is nevertheless quite as necessary. Obviously all sorts of valuable discoveries might be made and still be of no use to the farmers unless some means were provided for getting the results before them. With this fact in mind, a considerable portion of the efforts of the Station recently have been devoted to organizing this phase of the work. This has been particularly the case since the appropriation made by the last legislature has become available.

Thus in the Dairy Department much is being done in the way of field work among the creameries and dairies of the state. Practically the entire time of one man is taken up in visiting the different creameries and suggesting improvements in methods and in lecturing before gatherings of dairymen and creamery patrons. The services of this man have been very much in demand and such work is undoubtedly resulting in much benefit to the dairy interests of the state. Considerable has also been done in this connection in conducting educational butter scoring contests at the state fair and elsewhere during the year, and in testing dairy herds in different parts of the state.

In the Agricultural Department a large amount of extension work has been carried on during the year in connection with the state crop and soil improvement work. Practically the entire time of one man and a portion of the time of a number of other persons has been devoted to this work, which has consisted in running several special seed corn trains, lecturing before farmers' institutes, newspaper articles, special bulletins, exhibits at the state and county fairs, farmers' excursions and demonstration work at county fairs. This work, a detailed account of which will be found elsewhere, has proven extremely popular and has created a widespread interest, particularly along the line of corn production, which has been the principal phase of the Station work projected.

The possibilities of this work can be seen from the following figures: The corn production of the state this season is estimated at over 165,000,000 bushels, worth in round numbers about $65,000,000.00. From reports collected by the Station from different parts of the state it is estimated that the percentage of stand of corn this season is about 70.1. From data worked out by the Station it would seem that it should be possible by proper selection, testing and care of the seed, to secure a stand of 90 to 95 per cent, or an increase of more than 20 per cent over the stand of the present season. While an increase of 20 per cent in the stand might not

necessarily mean an increase of exactly 20 per cent in production, it would at least mean the greater part of this. An increase of but one per cent in production, which would certainly seem to be well within the limits of possible attainment by means of the distribution of knowledge through the corn trains, institute work, etc., would mean an increase in the wealth of the farmers of the state of fully $650,000.00 annually, sufficient to pay for the entire work of the Station to date several times over.

Cooperative Experiments.

Another very important part of the Extension work of the Station is the cooperative experimental work in progress throughout the state. Prior to the recent state appropriation, the criticism was often made that the work of the Station was too much confined to one locality. That while much valuable data had been worked out for the section immediately surrounding the Station, much of this did not apply to other sections of the state having different soil and climatic conditions. This was of course true to a very large extent, and while much of the Station work, such as all laboratory investigations, etc., must necessarily be confined to the central plant, there are a large number of investigations, dealing with such matters as the improvement of the soils and crops of the state, that must be taken up under the varying local conditions before exact knowledge applicable to all parts of the state can be secured. Realizing the force of this argument, as soon as the necessary funds became available, steps were at once taken to extend the work of the Station to all parts of the state.

With this end in view, cooperative experiments were arranged with farmers in different sections, for the purpose of testing varieties of the leading crops grown, conducting investigations concerning the breeding of corn and other crops, studying the effects of different fertilizers on different soils and crops of the state, conducting tests of dairy herds, conducting experiments for the purpose of ascertaining the best means of controlling the San Jose scale, codling moth and other orchard pests, conducting demonstration experiments at county poor farms, etc.

While many of the cooperative experiments have been simple in character, consisting of the testing of a number of the best varieties of corn or other crops for one or two seasons, or the testing of different combinations of fertilizers for a similar period, in a number of cases where desirable conditions have been found, systematic scientific investigations have been started to run through a series of years. The Station has been very fortunate in this connection in securing the active cooperation of a number of very com-

petent persons including several former agricultural students and a number of men of large means who have insisted upon furnishing every thing that could be desired in connection with the experiments in progress, absolutely free of cost to the Station.

Members of the Station Staff have visited the experiments in progress in different parts of the state in a large number of cases, and have given personal attention to the starting of the experiments, harvesting of the produce, etc. In this connection two or three men have been on the road most of the time during a considerable portion of the year, but even then it has been impossible to visit a large number of the experiments. In cases where personal supervision has been impossible, the work has been handled by means of instruction sheets and report blanks.

The farmers of the state are taking a very active interest in the cooperative work, as shown by the large number of requests received for such experiments, and the keen local interest manifested. We find the results secured are frequently referred to in the local papers, institutes, etc. The cooperative work is also of much value to the Station as it affords the means of securing reliable information in regard to conditions in different sections of the state that could not be secured in any other way. On the whole this phase of the Station work is proving very successful, and it is intended to still further extend it, especially along lines that have not yet been very fully developed.

The cooperative experiments in progress during the year have numbered 720, and have embraced every county in the state. They may be classified as follows:

Variety tests with corn	453
" " " wheat	38
" " " oats	30
" " " soy beans	56
" " " cow peas	36
Corn breeding plots	18
Crop rotation experiments	2
Drainage experiments	1
Fertilizer tests with corn	27
" " " wheat	4
" " " oats	3
" " " rye	1
" " " clover	3
" " " cow peas	2
" " " soy beans	1
" " " potatoes	8
" " " onions	3
" " " cherry trees	1

Herd tests	22
Official tests	3
Experiments with San Jose scale	6
" " vegetables	2
Total	720
Counties represented	92

Growth of Correspondence and Mailing List.

That the work of the Station is being appreciated more and more by the farmers of the state is indicated in a variety of ways, one of which is the enormous increase in the correspondence that has taken place in the last two or three years. At the present time anywhere from 30 or 40 to 200 or 300 letters are being received daily, and a similar number are being sent out. The services of four typewriter operators are required at the present time, where one sufficed a few years back. Another indication of the growing interest in the work of the Station by the farmers of the state is the rapid rate at which the bulletin mailing list is growing. In 1904 the names on the mailing list numbered 9,724, while in 1906 it had increased to 15,192.

The following tabulated statement shows the growth of the mailing list in detail for the past four years:—

	1902-3	1903-4	1904-5	1905-6
Names of persons in Indiana	6,870	7,227	8,254	11,169
Names of persons outside the state	1,293	1,539	2,211	2,959
Names of persons in foreign countries	173	196	197	240
Indiana periodicals	603	600	589	686
Outside state periodicals in U. S.	144	154	160	129
Periodicals (foreign)		8	15	9
Total	9,083	9,724	11,426	15,192

Publications During the Year.

During the year covered by this report seven regular bulletins and eleven press bulletins were published by the Station, compared with seven bulletins and six press bulletins for the year previous.

Several of the bulletins issued this year have been in very great demand not only in our own state but in other states and countries as well. It was found necessary to print a second edition in one or two cases. Some of the bulletins issued this season are being used very extensively in the schools of this state and elsewhere and by various agricultural organizations such as boys' corn clubs, etc., and

at least one of the bulletins has been reproduced in the annual report of the department of agriculture of another state. On the whole, the bulletins of the year have been very favorably received.

The following is a list of the publications during the year. A complete list of all bulletins published to December 1, 1906, will be found elsewhere in this report.

BULLETINS PUBLISHED BY THE EXPERIMENT STATION FOR THE YEAR ENDING JUNE 30, 1906.

Bulletin No. 107, Vol. XIII. July, 1905, pp. 1-12. Illustrations 1. Agriculture at Purdue University. By W. E. Stone.

Bulletin No. 108. Vol. XIII. July, 1905, pp. 13-32. Illustrations 4. Soy beans, middlings and tankage, as supplemental feeds in pork production. By J. H. Skinner.

Bulletin No. 109, Vol. XIII. November, 1905, pp. 33-76. Illustrations 28. Examination of horses for soundness. By G. H. Roberts and A. W. Bitting.

Bulletin No. 110. Vol. XIII. January, 1906, pp. 77-120. Illustrations 15. Corn Improvement. By. A. T. Wiancko.

Bulletin No. 111, Vol. XIII. March, 1906, pp. 121-134. Indiana plant diseases in 1905. By Frank D. Kern.

Bulletin No. 112, Vol. XIII. April, 1906. pp. 135-208. Maps 1. Commercial fertilizers. By Arthur Goss and W. J. Jones, Jr.

Bulletin No. 113, Vol. XIII. June, 1906. pp. 209-288. Illustrations 20. Characteristics of some of the contagious and infectious stock diseases. By A. W. Bitting and G. H. Roberts.

Report—Eighteenth, July 1, 1904 to July 1, 1905, pp. 46. By Arthur Goss, Director.

Press Bulletins.

No. 119. August 5, 1905. Results of variety tests of winter wheat. By M. L. Fisher.

No. 120. September 26, 1905. Select your seed corn now. By A. T. Wiancko.

No. 121. October 10, 1905. Hog Cholera. By. R. A. Craig.

No. 122. February 10, 1906. Results of variety tests of oats. By A. T. Wiancko.

No. 123. March 6, 1906. Nervous exhaustion and debility in breeding ewes. By R. A. Craig.

No. 124. March 10, 1906. Directions for testing the vitality of seed corn. By A. T. Wiancko.

No. 125. March 19, 1906. Treatment for oat smut. By J. C. Arthur.

No. 126. April 9, 1906. Treatment of lousy live stock. By R. A. Craig.

No. 127. April 14, 1906. Directions for grading seed corn and testing the planter. By A. T. Wiancko.

No. 128. April 21, 1906. Soy beans and cow peas. By A. T. Wiancko.

No. 129. May 16, 1906. Treatment of stomach worms of sheep. By R. A. Craig.

Changes in the Station Staff.

The following changes have occurred in the Station staff during the year covered by this report.

On July 6, 1905, G. I. Christie, a graduate of the Ontario and Iowa Agricultural Colleges, was appointed as Assistant Agriculturist. On September 1, W. A. Cochel, a graduate of the Missouri Agricultural College, was appointed Assistant in Animal Husbandry. On September 1, H. J. Fidler was appointed Assistant in the Dairy Department. On October 16, W. P. Kelley, a graduate of the Kentucky Agricultural College, was appointed Assistant in the Fertilizer Control Work. On October 1, Nola Sparks, Bookkeeper of the Station, resigned, and Jessie L. Cowing was appointed, October 25, to fill the vacancy. On November 3, Prof. H. E. Van Norman, head of the Dairy Department, resigned to accept a position of larger responsibility and higher remuneration, in the Pennsylvania State College, and December 1, Prof. O. F. Hunziker, a graduate of Cornell University, was chosen to fill the position made vacant by the resignation of Prof. VanNorman. On March 1, 1906, James Eldridge, Helper in the State Chemist Department, resigned to assume control of a large farm in the northern part of the State, John Wagner being appointed to fill the vacancy. On March 1, W. E. Osborn, working foreman in the Agricultural Department, resigned to take charge of a large dairy farm in the State, Harry Davis being appointed to fill the vacancy. On June 1, Walter Lane, in charge of the Station greenhouses, and foreman in the Horticultural Department, resigned on account of ill health. On June 15, L. S. Hasselman, a graduate of Purdue, was appointed Assistant Chemist. On June 18, C. O. Cromer, a Purdue graduate, was ap-

pointed Assistant Agriculturist. On June 30, H. N. Slater, Dairy Field Assistant, resigned to accept a higher salaried position with the U. S. Department of Agriculture.

At the end of the year, Dr. A. W. Bitting severed his connection with the Station, as his medical practice and other duties demanded his entire time.

Adams Act.

Perhaps the most important event of the year in connection with Station affairs was the passage of the Adams bill by the U. S. Congress. By the terms of this act the income of the Station will ultimately be increased $15,000.00 per annum. The following is a full text of the Adams Act:

"An Act to Provide for an increased annual appropriation for agricultural experiment stations and regulating the expenditure thereof.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there shall be, and hereby is, annually appropriated, out of any money in the Treasury not otherwise appropriated, to be paid as hereinafter provided, to each State and Territory, for the more complete endowment and maintenance of agricultural experiment stations now established or which may hereafter be established in accordance with the Act of Congress approved March second, eighteen hundred and eighty-seven, the sum of five thousand dollars in addition to the sum named in said Act for the year ending June thirtieth, nineteen hundred and six, and an annual increase of the amount of such appropriation thereafter for five years by an additional sum of two thousand dollars over the preceding year, and the annual amount to be paid thereafter to each State and Territory shall be thirty thousand dollars, to be applied only to paying the necessary expenses of conducting original researches or experiments bearing directly on the agricultural industry of the United States, having due regard to the varying conditions and needs of the respective States and Territories.

SEC. 2. That the sums hereby appropriated to the States and Territories for the further endowment and support of agricultural experiment stations shall be annually paid in equal quarterly payments on the first day of January, April, July, and October of each year by the Secretary of the Treasury, upon the warrant of the Secretary of Agriculture, out of the Treasury of the United States, to the treasurer or other officer duly appointed by the governiug boards of said experiment stations to receive the same, and such

officers shall be required to report to the Secretary of Agriculture on or before the first day of September of each year a detailed statement of the amount so received and of its disbursement, on schedules prescribed by the Secretary of Agriculture. The grants of money authorized by this Act are made subject to legislative assent of the several States and Territories to the purpose of said grants: *Provided,* That payment of such installments of the appropriation herein made as shall become due to any State or Territory before the adjournment of the regular session of legislature meeting next after the passage of this Act shall be made upon the assent of the governor thereof, duly certified by the Secretary of the Treasury.

SEC. 3. That if any portion of the moneys received by the designated officer of any State or Territory for the further and more complete endowment, support, and maintenance of agricultural experiment stations as provided in this Act shall by any action or contingency be diminished or lost or be misapplied, it shall be replaced by said State or Territory to which it belongs, and until so replaced no subsequent appropriation shall be apportioned or paid to such State or Territory; and no portion of said moneys exceeding five per centum of each annual appropriation shall be applied, directly or indirectly, under any pretense whatever, to the purchase, erection, preservation, or repair of any building or buildings, or to the purchase or rental of land. It shall be the duty of each of said stations annually, on or before the first day of February, to make to the governor of the State or Territory in which it is located a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of said stations, to the Secretary of Agriculture, and to the Secretary of the Treasury of the United States.

SEC. 4. That on or before the first day of July in each year after the passage of this Act the Secretary of Agriculture shall ascertain and certify to the Secretary of the Treasury as to each State and Territory whether it is complying with the provisions of this Act and is entitled to receive its share of the annual appropriation for agricultural experiment stations under this Act and the amount which thereupon each is entitled, respectively, to receive. If the Secretary of Agriculture shall withhold a certificate from any State or Territory; and no portion of said moneys exceeding five per be reported to the President and the amount involved shall be kept separate in the Treasury until the close of the next Congress in order that the State or Territory may, if it shall so desire, appeal to Congress from the determination of the Secretary of Agriculture. If the next Congress shall not direct such sum to be paid, it shall be covered into the Treasury; and the Secretary of Agriculture is hereby charged with the proper administration of this law.

Sec. 5. That the Secretary of Agriculture shall make an annual report to Congress on the receipts and expenditures and work of the agricultural experiment stations in all of the States and Territories, and also whether the appropriation of any State or Territory has been withheld; and if so, the reason therefor.

Sec. 6. That Congress may at any time amend, suspend, or repeal any or all of the provisions of this Act.

Approved, March 16, 1906."

Owing to the fact that the Comptroller of the Treasury ruled that the first $5,000.00 of the Adams fund would not be available for the year ending June 30, 1906, and that the same was only made available by special act of Congress, during the latter part of the last week in June, the Indiana Station, as well as others, failed to get the benefit of the first year's appropriation. As we were, however, receiving for the first time the full amount of the State appropriation, this was a matter of less importance than would have been the case at any other time in the history of the Station.

As an illustration of the fact that important matters may sometimes hinge on small things a portion of the ruling of the Comptroller is quoted below:

"If a comma had separated the words "act" and "for," supra, Congress would have evidenced its intent to make the appropriation of $5,000.00 carried for the first year to each station applicable to the fiscal year 1906. But the comma is not there. Punctuation may be supplied to make an act intelligible and operative, but should not be supplied by construction when its effect would be to confuse and make a bill wholly or partially inoperative. Such would be the case if the comma were supplied in the language supra. I therefore answer your first question (as to whether the first $5,000.00 was available for the year ending June 30, 1906) in the negative."

As this ruling applied to all the states in the Union, it can be seen that the comma mentioned by the Comptroller was rather an expensive punctuation mark.

It will be noted by referring to the Adams act that the use of the funds provided is very much restricted. The Secretary of Agriculture who is charged with the administration of the fund has made the following ruling in regard to the things for which it may be used:

"The Adams fund is to be applied only to paying the necessary expenses of conducting original researches or experiments bearing directly on the agricultural industry of the United States. It is for the more complete endowment and maintenance of the experiment stations, presupposing the provision of a working plant and administrative officers. Accordingly, expenses for administration,

care of buildings and grounds, insurance, office furniture, and fittings, general maintenance of the Station farm and animals, verification and demonstration experiments, compilations, farmers' institute work, traveling, except as is immediately connected with original researches in progress under this act, and other general expenses for the maintenance of the experiment stations, are not to be charged to this fund. The act makes no provision for printing or for the distribution of publications, which should be charged to other funds."

From the above it will be seen that the use of the Adams fund is limited to research work only. This appropriation in no way relieves the state of the necessity of supporting the station, but on the other hand, increases its responsibility in this connection, as the necessary plant for carrying out the provisions of the Adams fund is supposed to be furnished by the state as well as all general expenses, including the publication of results. It is also to be noted that practically none of the soil improvement work, dairy work and live stock feeding work provided for under the recent state appropriation, and now being carried on, would be possible under the Adams act, as this work while equally important, is of a more popular character than the original research work contemplated under the Adams act.

By using the state appropriation largely for the purpose of conducting demonstration and cooperative experiments in different parts of the state and to project the scientific work done under the Hatch, Adams, and State funds, by means of lectures, institute work, corn train work, work in the creameries, etc., much better results should be secured from now on than have been possible under the financially restricted and unbalanced conditions existing in the past.

Advisory Committee.

The Advisory Committee from the State Corn Growers' Association, State Live Stock Association, and State Dairy Association, provided for in the law creating the recent State appropriation, met during the year, discussed the work in progress and contemplated under the Smith Act, and made many valuable suggestions in regard to the same. They also discussed future needs of the Station, and after carefully inspecting the building occupied at present, sent a communication to the Board of Trustees of the University, calling attention to the unsafe condition of the building, and to the fact that it is inadequate to the growing needs of the Station, and suggested the urgent necessity of Legislative action for the purpose of providing a new building.

The members of the Advisory Committee are in very close touch with both Station affairs and the farmers of the State, and

their advice has proven very helpful to the Director in conducting the affairs of the Station, particularly in connection with the State work.

Needs of the Station.

Undoubtedly the most urgent need of the Station at the present time is for a new building. The necessity for a new Station building has been pointed out by the different directors for a number of years past. The building now occupied, owing to the manner in which it is cut up into numerous small rooms, is very poorly adapted to the needs of the different laboratories, for which it was never designed.

Owing to the lack of funds, the building when erected was of such cheap and inferior construction that it settled and cracked to such an extent that it has all but fallen down, and is at the present time only held together by rods. About 1896 the building was condemned as unsafe by an Indianapolis architect and was chained off from use. After it was temporarily tied together it was again occupied under protest. The settling has continued since that time and is going on at the present moment, as can easily be determined. It would seem that it is hardly fair to the Station employees to require them to work under such conditions.

During the last two or three years the business of the Station has increased three or four fold and the building that was entirely inadequate for the needs of the Station before that time, certainly can scarcely be expected to satisfactorily accommodate the work now.

With the present unsafe, inadequate, poorly designed building, as an essential factor in the calculation, it is impossible to figure out permanent plans as to quarters and equipment for the different lines of work, and anything that is done must necessarily be of a temporary and unsatisfactory character.

Another matter of legislation urgently needed by the agricultural interests of the state is a stock food control law, along similar lines to the present fertilizer control law. Some 18 or 20 of the most important states, including nearly all our neighbors, have such laws at the present time, and under existing conditions Indiana becomes the dumping ground for adulterated and fraudulent stock foods that cannot be marketed elsewhere. Many examples of such conditions have recently been brought to our attention and a number of samples have been analyzed in the chemical department which had practically no value whatever as feeding stuffs, but which were being sold to the farmers at fancy prices. Such conditions may, of course, be expected to continue until we have a stock food law similar to other states.

By placing the law on a fee basis, as is the case with the stock food laws in most other states and as is the case with our state fertilizer control law, the matter could be made self supporting and would require no legislative appropriation.

In order to be in a position to answer the numerous questions received, the Station recently secured copies of the stock food laws of all the different states and is at present working these over, with a view to seeing how such laws are administered elsewhere and what would probably best suit the conditions in our state.

The demand for such a law is very extensive, as shown by the fact that quite a number of agricultural organizations, such as the State Live Stock Association, the State Dairy Association, and a number of farmers' institutes, have recently passed resolutions calling for such legislation. While such a law would be of more direct interest to the feeders of the state than to the Station, and should be pushed by them, it seems to be the general desire that such a law should be administered by the Experiment Station, as is the case in most of the states that have stock food laws, and the matter is consequently mentioned here.

Respectfully submitted,

ARTHUR GOSS, Director.

Report of the Agricultural Department.

ARTHUR GOSS, Director.

Sir:—I take pleasure in submitting the following brief account of the work of the Department of Agriculture, for the year ending June 30, 1906:

The attention of the Department during the year has been given largely to working out the problems in crop production which are of the greatest interest to the farmers of the State at the present time. The increase in the funds available for this work has made it possible to materially extend several of the most important experiments. In crop improvement most attention has been given to corn and wheat. Considerable has also been done in further investigating the adaptability of alfalfa, cow peas, and soy beans to the conditions in different parts of the state, as it is believed that these crops are worthy of thorough trial, and can probably be used to good advantage on many farms. Additions have also been made to the experiments designed to determine the most profitable systems of crop rotation, and a comprehensive set of experiments in corn cultural methods has been started.

Experiments with Corn. The testing of varieties throughout the state in cooperation with interested farmers, has been considerably extended this year with the fund available from the state appropriation. The objects of this work are to determine the relative merits of the better varieties of corn in various sections of the state, with a view to finding out what varieties should be recommended to farmers in the several sections; to determine the varieties most suitable for foundation stock in the work of breeding corn for any given locality, and to bring the better varieties to the notice of farmers by giving as many as possible an opportunity to test them on their own farms. Twenty of the most promising varieties that could be found are included in these tests and have been distributed over the state, five for each section, according to probable adaptability. Every farmer who wishes to make one of these tests is first furnished with a list of the varieties selected for trial in his section, and a printed copy of the directions for conducting the test. Upon agreement to comply with the directions and properly report the results, he is supplied with carefully prepared seed sufficient to plant a quarter acre of each of five varieties. This year 453 such tests were undertaken on as many different farms, distributed over 88 of the 92 counties in the state. Many reports show that these local tests attract quite a lot of attention in the neighborhoods where they are located and are undoubtedly doing a great amount of good in arousing interest in corn improvement,

besides pointing out to farmers the differences between varieties and acquainting them with the better ones.

As an investigation preliminary to systematic corn breeding work, this testing of varieties has shown that there are wide variations in the requirements of different sections of the state, and that each must have a distinct type of corn in order to secure the best results. It points out very clearly that the Experiment Station, in order to be of the most service to farmers, must carry on its crop improvement work in the localities where the crops, are to be used. In other words, a variety produced in one section is not likely to be suitable to another section at any considerable distance from it.

Corn improvement work by systematic methods of breeding and selecting for higher yielding powers and better quality, is now being carried on under the management of the Department in eight distinct districts of the state, each of which has its own variety requirements, by reason of different soil and climatic conditions. The object of this work is to produce within each district one or more strains of corn specially adapted to it, and to establish good sources of seed supply. In addition to the breeding work directly under the control of the Department, a lot of work is being done in directing the efforts of a number of seed corn growers who are using the Department's methods to improve the corn they are offering for seed. Incidentally, a lot of interesting data concerning breeding methods and the best types of ears to select for seed, is being collected, which will probably be of considerable value in further improvement.

While it is still too early to draw any definite conclusions concerning the value of this work, it may be said that the results so far are very encouraging. In one of the experiments, where we have the results of three years' work, seed of the specially bred corn was planted in the even numbered rows of a forty-eight row plot, and well selected seed from a field of the original corn on the same farm was planted in the odd numbered rows. The twenty-four even numbered rows produced 80.8 bushels per acre, and the twenty-four odd numbered rows produced 73.2 bushels per acre. When calculated to a uniform basis of a hundred per cent stand, the yields stood 89.5 to 80.8 respectively, showing a difference of 8.7 bushels per acre in favor of the specially bred corn.

A comprehensive experiment in corn cultural methods was begun this year on a clay loam soil in Hamilton county to study the effects of various types of cultivators, various depths, and various frequencies of cultivation upon the yields of corn. Efforts are being made to locate similar experiments on other distinct types of soil. These experiments will be carried through a number of seasons, and will enable us to more intelligently answer the many questions that come to us concerning these matters.

Experiments with Winter Wheat. The testing of new varieties has been continued as heretofore on the University Farm. Several of the most promising varieties are being tried in various parts of the state by means of co-operative tests similar to those made with varieties of corn. By this means many farmers are becoming acquainted with varieties better suited to their conditions than those which they had been growing. This cooperative work is also of great service to us in establishing good local sources of seed supply, to which we can refer farmers in the neighborhood.

The more careful work of improving wheats by selective breeding is being conducted on the University Farm. The object of this work is to produce strains or varieties with greater yielding powers, greater hardiness, and better milling qualities, and the indications are that much good may be accomplished in the course of a few years. Careful studies of the subject indicate that wheat production is bound to retain an important place in Indiana agriculture, and the work of the Station along this line promises to yield valuable results.

Oats. The experiments with oats have been similar to those with wheat, though on a somewhat smaller scale. A number of very promising varieties have been introduced, and much good is expected from the cooperative tests throughout the state. Investigation has shown that the average farmer has been very careless with his oats crop, both in its treatment in the field, and in the selection of seed. Run-out varieties are responsible for many low yields of poor quality, and considerable improvement should be easily made.

Cow Peas and Soy Beans. The experiments with cow peas and soy beans are yielding very encouraging results. When the proper methods of growing and using these crops become more widely known, they will find important places in Indiana agriculture, both as stock foods and soil improvers. Ninety-two co-operative tests with several varieties of these crops were distributed over the state last spring, and our correspondence indicates that many farmers are seriously considering their use.

Alfalfa. Concerning alfalfa culture, a large number of experiments are being made to determine the best time and the best methods of seeding and establishing fields of this valuable forage crop.

Other Minor Crops. Quite a number of minor crops, such as barley, rye, emmer, buckwheat, broom corn, millets, sorghum, and various other forage crops and novelties, are being tested with a view to studying their adaptability and value under our conditions, so that we may be able to give intelligent answers to the many questions that come to us concerning them.

Crop Rotations. In addition to the experiments with various crop rotations upon the University Farm, which have been reported

from time to time, several series have been started on farms in Southern Indiana, in Scott and Pike counties. Careful attention has been given to the planning and establishing of these experiments in cooperation with the Chemical Department, which is conducting the fertilizer investigations connected with them.

Correspondence. The correspondence of the Department with farmers has been growing rapidly, and is worthy of note as an indication of increasing interest and confidence in the work of the Station. Much time and attention is given to answering questions and aiding inquiries to secure the information they desire, which must often be very helpful in bringing about improvements.

Respectfully submitted,

A. T. Wiancko, Agriculturist.

Report of Agricultural Extension Work.

Arthur Goss, Director.

Sir: As a part of the work of the Agricultural Department, a considerable amount of extension work has been carried on during the year. Through this medium efforts have been made to place before the farmers of the state, in a practical manner, the results of experimental investigations. This has been accomplished by lectures before farmers' institutes, corn and agricultural clubs, the use of special trains, newspaper articles, special bulletins, exhibits at county and state fairs, farmers' excursions and demonstration work on county farms. The work, although entirely new in some respects, has been received most favorably by the entire agricultural class. So many and urgent have been the demands for assistance and information along the lines suggested, that the department has been taxed to its utmost capacity.

One of the most important features of the year's work was the running of two special seed-corn trains, December 26, 27, 28, 29, 1905, and March 26, 27, 28, 29, 1906, over the Lake Erie and Western and Monon railroads respectively. These trains were equipped with engine, baggage car, two audience coaches and a guest coach, by the railroad company, and furnished free for the use of the Experiment Station.

The audience coaches were fitted up with charts and other demonstration material used in presenting the subject of harvesting, storing, selecting, testing and grading of seed corn. To assist in giving the talks, D. F. Maish, of Frankfort, Ind., and J. P. Davis, of Sheridan, Ind., were engaged.

The trains ran through twenty-eight counties in the corn belt of the state. Eighty-two stops, of 30 minutes each, for lectures, were made, and it was estimated that over 20,000 farmers heard the lectures and received bulletins pertaining to the work. In every way this innovation was a grand success, and proved of great value in bringing the Station work directly before the people of the State. It is generally felt that similar trains could be run over all lines in the state with profit to the railroads and farmers.

Another feature of the extension work is that of demonstrations on the county farms in different counties of the state. Owing to the fact that the work is new, the scope covered was necessarily limited. This year the work consisted of a test of varieties of corn grown by farmers in the county in which the test was conducted.

For this experimental or demonstrative work, the county commissioners were asked to set aside a part of a field on the county farm and to appropriate from county funds sufficient money to cover the expenses incurred.

Only two counties, Clinton and Randolph, were approached on this subject. Both counties responded and the work received a successful start.

On the Clinton county farm 30 varieties of corn from as many farmers, were planted in plots side by side, while 28 varieties were planted on the Randolph county farm.

The objects of this work are:

1. To gain the farmers' interest in experimental work. Experiments carried on at the State Experiment Station do not appeal to the people as strongly as those conducted nearer home.

2. To encourage improvement in the growing of grains by the elimination of poor varieties and the introducing of good ones.

3. To solve problems for the farmers than can best be done on soils and under climatic conditions exactly the same as those they must deal with.

As the work advances, a study of the varieties of small grain, fertilizer tests and lines of horticultural work will be taken up. This field already gives promise of some valuable results and should receive most careful attention from the Experiment Station.

During the early summer, farmers' excursions were run from LaPorte, Hamilton, Hendricks and Clinton counties to the University and Experiment Station. More than 2,000 farmers, their wives, sons and daughters came at this time. Much of the time of these excursionists was spent in studying the soil and crop experi-

ments in the field, the animal husbandry, dairy and horticultural work. Through these excursions the farmers were brought in close touch with the Experiment Station men and work, and their interest in the results of all future work is necessarily increased.

Respectfully submitted,
G. I. CHRISTIE,
Associate in Agricultural Extension.

Report of the Horticultural Department.

ARTHUR GOSS, Director.

Sir:—The following is a brief statement of the experimental work of the Horticultural Department for the past year:

As mentioned in my last report, much of the work is of a continuous nature, requiring several years to show any definite results. The orchard fertilizer experiments are of this nature. One of these, in Southern Indiana, has been in progress now for three years, but up to the present time there is not enough difference manifested between the fertilized and the unfertilized to be perceptible in the growth of the trees. The soil here is of a red clay nature, naturally well adapted to the growth of apple trees. The application of mineral phosphates as a preventive of the root-rot in trees has not given any satisfactory results thus far.

It will require at least another year to get any definite results from the orchard in the northern end of the state, which is planted upon sandy soil.

Pedigreed Strawberry Plants. Last year our experience with the so-called pedigreed strawberry plants, as compared with the same varieties grown in the usual way, was decidedly in favor of the common method. The experiment was continued, with the same beds, another season, but a late frost and prolonged drouth at fruiting time cut the experiment short, so that no definite results could be obtained this season.

Commercial Fertilizers on Tomatoes. This experiment had a threefold object in view, 1. Testing the effect of commercial fertilizers on tomatoes. 2. Testing varieties. 3. Testing the productivity of individual plants. Twelve varieties were used and 18 plants to each variety, making 216 plants. The varieties were planted in rows four feet apart each way, and the fertilizer, consisting of acid phosphate, muriate of potash, and nitrate of soda, was applied, in varying quantities, *across* the varietal rows. The fruit of each of the 216 plants was picked and weighed separately during

the ripening season. One of the most interesting results noted was the great variation between individual plants in their productive qualities, some plants of the same varieties and with the same treatment producing as much as five times as much fruit as others. Here is a point in plant breeding that is evidently not taken into account by seedsmen when selecting their seed fruits.

Varietal Tests. The ordinary varietal tests of orchard and small fruits have been continued, and about 100 varieties of strawberries will be ready to report upon next season, a number of these being seedlings of our own raising.

Spraying Experiments. Last spring a power sprayer, manufactured by the Wallace Company of Champaign, Ill., was purchased, and nearly all of our experimental work was done with this outfit. It was much more satisfactory than the barrel pump heretofore used, as with it we are able to get a greater force and therefore a finer spray, which is very desirable, and we are also able to maintain a steady pressure, which is also an important feature of the work. In spraying for the control of the codling moth in the apple our results this year as well as last, have shown very conclusively that for the second brood, two applications, one about July 14th and the other July 25th, are much more effective than where only one application is made.

Our experiments for the control of the San Jose scale have been mostly of a cooperative nature. Those taking part in these experiments were W. J. Ritterskamp and Henry Yeager of Princeton, Gibson county; W. W. Clark, Elizabeth, Harrison county; E. J. Walker, Sheridan, Hamilton county; L. E. Hibben and Hilton U. Brown, Irvington, Marion county.

Other cooperative experiments on the growing of onions and potatoes have been carried on during the past season with Mr. R. A. Lockwood, near Dayton, Tippecanoe county, and Mr. J. N. Snodgrass, of Kirklin, Clinton county.

Respectfully submitted,

JAMES TROOP, Horticulturist.

Report of the Chemical Department.

Arthur Goss, Director.

Sir:—The following is a brief report of the work of the Chemical Department for the year ending June 30th, 1906.

General Analytical Work.

1. The study of the corn plant under different conditions of moisture and fertilization was continued. Notwithstanding that the rainfall in 1905 was such that very little irrigation was required (three times in August) it was found on harvesting the corn on the plats on November 2, 1905, that there was a marked increase in the yield of the plats to which water had been applied. This increase varied from one and six tenths to fifteen bushels per acre on comparative irrigated and unirrigated plats. Analyses are being made of the produce from the different plats. This investigation will be continued until several years' results are available.

2. In connection with the fertilizer test work in progress, the study of the water underlying the muck soil on the farm of L. G. Nice in Tippecanoe county has been continued.

In this connection fifty-eight samples of soils and sub-soils from different parts of the state have also been analyzed during the year.

3. The work of the Associate Chemist on natural phospnates that has been in progress for a number of years past has been continued, but owing to the large amount of routine work but little headway has been made the past year. It is hoped that conditions will soon be such that this work may be finished, as there seems to be a demand for the facts which are being brought out by this investigation.

4. In connection with the fertilizer control work the study of the neutral ammonium citrate solution and methods of preparing same is being continued, with results greatly favoring the use of the Calcium Chloride (Alternate) method of the A. O. A. C.

5. In connection with the fertilizer control work an investigation has also been conducted during the year concerning the effect on the content of available phosphoric acid of re-grinding and allowing inspection samples to stand in the laboratory. For this purpose the soluble phosphoric acid was washed out of two hundred and fifty-five samples and the residues held until the samples were reached in the regular inspection work, at which time the soluble phosphoric acid was washed from a duplicate portion of the original sample and the residues from the first and second washings

digested at the same time with the same solution of neutral ammonium citrate. Of the two hundred and fifty-five samples so tested, one hundred and seventy-six showed a gain in available phosphoric acid as follows: forty-four gained one tenth per cent, forty-seven gained two tenths per cent, twenty-five gained three tenths per cent, fourteen gained four tenths per cent, thirteen gained five tenths per cent, two gained six tenths per cent, two gained seven tenths per cent, one gained nine tenths per cent, two gained one and two tenths per cent and one gained one and six tenths per cent. Eleven samples showed no change and sixty-eight showed a diminished per cent of available phosphoric acid. In twenty-five samples the decreased quantity could not be accounted for as variation in analytical work. These twenty-five samples may be classified as follows: Nine decreased one tenth per cent, ten decreased two tenths per cent, four decreased three tenths per cent, one decreased seven tenths per cent and one decreased nine tenths per cent. The figures given are to the nearest decimal place. Where the variation between the two insolubles was less than one tenth per cent it was considered within the range of analytical error.

This investigation is being continued with a view to determining whether there is any change in the residues due to standing before digestion with citrate after the soluble phosphoric acid is removed.

6. Considerable work has been done during the year on methods for recovering platinum from the platinum waste obtained in the determination of potassium. The method proposed by K. P. McElroy, Journal American Chemical Society, March, 1897, page 260, in which the platinum is reduced from a hydrochloric acid solution by means of aluminum foil, has been adopted as giving the best results.

7. Samples of cattle and poultry foods have been analyzed during the year for farmers and others as follows: one of bran, one of ship stuff, one of corn meal, one of gluten feed, (in this sample the protein content was much too low for a genuine gluten feed and though sold as such it should have properly been classed as a hominy feed), one of old process linseed meal, two of prime cotton seed meal, one of Royal Stock Food, one of Royal Poultry Food and two of wild hay.

The results of the analysis of the various samples of cattle feed emphasize anew the point mentioned in the 1905 report that a stock food law similar to our fertilizer law insuring a rigid inspection of the feeds offered for sale in this state is urgently needed.

8. Other miscellaneous samples have been analyzed as follows: Two of water, one of straw board waste, three of corn cob ashes,

one of sugar beets, six of Alabama red clay, one of Indiana red clay, one of Venetian Red and one of hematite.

COOPERATIVE WORK.

In cooperation with other departments of the Station the following work has been done during the year.

Agricultural Department. The work in corn breeding was continued. Three hundred and twenty-five samples of corn were analyzed, necessitating three hundred and forty-six determinations of moisture, three hundred and forty-seven determinations of nitrogen and three hundred and forty-five determinations of fat.

Dairy Department. (a) An investigation with a view to utilizing the buttermilk from Pasteurized cream in the manufacture of cottage cheese is under way. In this work a number of samples of buttermilk and cottage cheese made from the same have been analyzed and a special vat is now being constructed which it is believed will result in a successful method of recovering the casein from buttermilk.

(b) The efficiency of the Babcock test on milk, cream, skim milk, buttermilk and condensed milk under varying conditions is being determined.

(c) The effect of the addition of sodium hydrate on the fat content of sour milk when added to dissolve the curd was investigated. This problem required the analysis of the sweet milk before and after the addition of sodium hydrate and the analysis of the samples after souring. Varying strengths of sodium hydrate were added and it was found that such additions did not affect the fat content, concordant results being obtained by the ether extraction and Babcock methods.

(d) Methods for determining moisture by centrifugal force are being investigated.

In the above investigations, most of which are still in progress, there have been analyzed three samples of butter, one of sweet milk four of sour milk, five of buttermilk and five of cottage cheese made from buttermilk.

(e) The work on the moisture content of butter under differing conditions of manufacture was concluded with the determination of moisture in five samples of butter.

Three samples of butter submitted to the Dairy Association for prizes were analyzed and numerous Babcock fat bottles and other pieces of apparatus were calibrated for the Dairy Department.

Animal Husbandry Department. For this department the following samples were analyzed: two of shorts two of bran one of ship stuff, one of tankage, one of oats feed, one of corn feed and one of corn meal.

Veterinary Department. In cooperation with this department considerable chemical work has been done on samples of corn supposed to have produced on cattle eating it results similar to those observed in the so-called corn-stalk disease. Positive results at present are lacking, but the work is being continued in the hope that some definite conclusions may be reached.

FERTILIZER TEST WORK.

The cooperative fertilizer test work that has been in progress for several years past, has been considerably extended during the year covered by this report. During the past year 53 such tests have been conducted in 44 different places in the state as follows:

With corn	27
" wheat	4
" oats	3
" rye	1
" clover	3
" cow peas	2
" soy beans	1
" onions	3
" potatoes	8
" cherry trees	1
Total	53

The above tests have included practically all the important types of soil in the state and have involved tests of the following materials: dried blood, nitrate of soda, bone, acid phosphate, dicalcic phosphate, rock phosphate, muriate of potash, sulfate of potash, carbonate of potash, ashes, slaked lime, ground limestone, iron sulfate, iron hydrate, magnesium sulfate, magnesium carbonate, sodium sulfate, copper sulfate, carbon black, muck, clay, straw, manure and legume crops.

Some of the problems being investigated in this connection are— 1. The test of different fertilizer and legume crop combinations on different soils and crops of the state with the view of determining the most profitable combination to use in different cases. 2. A study of the lasting effect of fertilizers. 3. A comparison of different forms of nitrogen, phosphoric acid, potash and lime compounds, with a view of determining the best and most economical form to use in given cases. 4. A comparison of commercial fertilizers with manure. 5. A comparison of the effect of fertilizers on drained and undrained land. 6. A study of the injurious effect of fertilizers on the germination of corn. 7. A study of the effect of fertilizers in lessening the effects of bad seasons and insect

ravages. 8. A study of the effect of fertilizers in aiding to secure a stand of clover. 9. An investigation to determine the most profitable amounts of fertilizer to use. 10. A study of the effect of different fertilizers on the quality of the produce. 11. A study as to whether the continued use of fertilizer will injure the land.

A number of other things of a similar character are being investigated, but the above are perhaps sufficient to give a general idea of what we are attempting to do.

While it is impossible at this time to go into details as to the results that have been secured in this work it may be said in a general way that while occasionally soils are found that do not respond to fertilizers, usually some combination has been found that will produce handsome profits and not infrequently enormous returns. There is for example no question that the application of potash in considerable quantities on muck soil is very profitable in connection with the growing of corn and other crops. It also seems certain that the liberal use of fertilizer on the potato crop is highly profitable, and that fertilizer will usually pay well on the wheat and corn crops, if used in the proper proportions and right amounts. The work that has been done emphasizes the fact however, that in order to secure the best results it is necessary to understand the needs of the particular soil, and crop to be used. It is a very easy matter to waste a large amount of money in the use of fertilizers through the application of unnecessary elements, and improper forms of plant food, and the only wonder is that such satisfactory results are secured under the present haphazard system in vogue. There is not the slightest doubt that a large and profitable increase in crop production could be brought about in the state by a more systematic and intelligent use of fertilizers.

State Chemist's Work.

The work of the State Chemist has been conducted as in previous years. Our deputies visited every county in the state where fertilizer is sold, stopping at one hundred and eighty towns in the fall of 1905 and two hundred towns in the spring of 1906. Four hundred and twenty-six samples were secured in the fall of 1905 and the results of the analyses have been published in Bulletin No. 112. Three hundred and thirty-five samples were secured in the spring of 1906, the results of the analyses of which are nearly ready for transmission to the manufacturer and consumer. The analysis of these samples required 1181 determinations of total prosphoric acid, 1258 determinations of insoluble phosphoric acid, 780 determinations of nitrogen and 864 determinations of potash.

The amount of fertilizer sold in the state in 1905, based on tags sold, was considerably in excess of that sold in 1904, but a

comparison of the sales for the spring of 1905 with a similar period in 1906, indicates a reduction in the sales for the latter period of seven thousand tons. Crop conditions at the present time, however, indicate an increased consumption for the fall.

Nine cases for selling fertilizer without tags have been reported to the prosecutors of the various districts.

The office work and letters requesting information on fertilizer questions are constantly increasing and practically the entire time of the Chief Deputy is demanded in attending to the same.

The work of the department is in excellent condition and much credit is due to the deputies for their very efficient work.

ARTHUR GOSS, Chemist.
W. J. JONES, JR., Associate Chemist.

Report of the Botanical Department.

ARTHUR GOSS, Director.

Sir:—During the year ending June 30, 1906, the work of the Botanical department has been devoted more largely than heretofore to the study of parasitic fungi. During this time much advance has been made, especially in the study of rusts. The gathering of data by means of circulars, and issuing of bulletin No. 111 on "Indiana Plant Diseases in 1905," has called additional attention to this line of work throughout the State. The interest in mushroom growing, and in the edible mushrooms of the fields, is constantly increasing, and requests for information often exceed the resources of the Department to answer fully. Suitable facilities for growing and experimenting with this crop are much needed, and a larger library for the identification of the wild forms would be of service. The personnel of the Department has remained unchanged throughout the year.

Plant Diseases. The study of parasitic diseases of agricultural crops has continued during the year. The interest taken by farmers, orchardists and gardners all over the State, and their willingness to make reports and answer queries sent out by the Department, has furnished a considerable amount of information useful as a basis for work and an indication of the lines most needing investigation. Through letters many suggestions about methods of control, prevention and remedies have been sent out in addition to a bulletin upon the subject. The bulletin discussed the more notable diseases, estimating the extent of injury whenever possible, together with a consideration of remedies, preventives and an explanation of conditions which render crops less susceptible to dis-

ease. The scope of the work has been extended with the hope that a more complete and valuable report may soon be issued. More than fifty diseases have been observed doing considerable damage within the state, caused for the most part by parasitic fungi.

Plant Rusts. The intensive investigation of rusts of all classes of plants carried on during several previous years has been continued. A new classification of the whole group of rusts, mentioned in the last annual report, appeared during the year as a part of the proceedings of the International Botanical Congress, held at Vienna in June, 1905. The extended and complete descriptive account of all species known to occur in North America is nearing completion and will appear in print during the coming year as a part of the current North American Flora, a publication of the New York Botanical Garden. The rust problems are of universal importance and it is expected that the issue of a standard work of reference will elicit and make possible the co-operation of investigators in other states which may ultimately lead to some solutions of practical problems.

The most notable single result of the spring culture work was the discovery of the full life-cycle of the flax rust. This rust differs from most of those on farm crops in having all its spore-forms on one kind of plant. The first stage of the rust appears very early, often when the flax is just above ground, and the infection comes from the rusted straw or stubble left in the field over winter. Plans for controlling the rust may now be devised with probability of success.

The grain rusts were not bad during the year, the crops ripening before the fungus attained sufficient headway to do much damage.

A large series of wheat plats which were intended primarily to show the effect of various fertilizers upon wheat, were examined to ascertain whether the amount or kind of fertilizer had any effect upon the amount of rust. No appreciable differences could be made out as a result of the various fertilizers. It was evident, however, that fertilizer, or any other factor, which has tendency to produce early ripening, was an advantage in decreasing the amount of damage from rust. Only a few days of lagging at the ripening time affords opportunity for considerable destruction.

Weeds, Seeds, etc. Many inquiries concerning identification of weeds have been received. Much attention has been paid to the answering of these in order to assist in exterminating and preventing the spread of pernicious kinds.

Detection of adulteration of seeds of grasses and forage crops has also demanded attention and often furnishes valuable information to the grower.

Seed oats treated with formalin on a large scale at an elevator, as recommended in Bulletin No. 103, were tested, and proved the treatment entirely effective in freeing them from spores of smut and other fungi.

Respectfully submitted,

J. C. ARTHUR,

Botanist.

Report of the Animal Husbandry Department.

ARTHUR GOSS, Director.

Sir:—During the year ending June 30, 1906, the scope of work in the Animal Husbandry Department has been greatly enlarged. A full time assistant has been added to the staff, and a beginning made in the study of beef production in Indiana. The work of this Department has been largely devoted to swine and cattle.

Swine. Bulletin 108, "Soy Beans, Middlings and Tankage as Supplemental Feeds in Pork Production," published in July, 1905, has been widely copied by agricultural papers. This has resulted in many inquiries in regard to the work from different parts of the United States, especially Indiana, Ohio, Pennsylvania, Illinois and Iowa. These inquiries indicate a widespread interest in experimental pig feeding and especial interest in the growing and feeding of soy beans.

In the experiment reported in Bulletin 108 it required less feed per 100 pounds of gain where soy beans were fed, than where middlings or tankage were fed, while the pigs receiving corn and soy beans made 120% greater gain than those receiving corn only and 10% more gain than any other lot in the experiment. The results of the test indicate the efficiency of this grain as a supplement to corn in pig feeding. At least four stations have conducted feeding experiments with soy beans and all report favorable results.

In the fall of 1905 a third experiment was conducted to determine the value of soy beans in pork production, where they are harvested by turning the pigs into the field when the beans are ripe. This work, which was begun in 1903 is progressing favorably and results will be published when sufficient material is at hand.

Bacon Hogs. Investigation along this line has been continued in order to secure further information in regard to the influence of Yorkshire blood on various breeds representing lard types of swine, and a feeding experiment conducted in which Berkshires, Poland Chinas and Yorkshires were compared.

Two new lines of work have been taken up, one a study of the comparative value of tankage and oil meal as supplements to corn for dry lot pig feeding, including a study of the effect of silage; the other a study of the value of different kinds of green forage for growing pigs.

Cattle feeding. This year marks a distinct advance in this line of Animal Husbandry in Indiana. The appropriation of $5,000 annually for live stock feeding made possible the beginning of this important line of work. During the summer an equipment of yards, sheds, scale, water tanks, etc., was installed to accommodate three car-loads of cattle. Previous to 1905 funds were inadequate for such work, consequently the first test was planned with the thought of simplicity and practicability. The purpose of the experiment was to compare different rations for fattening steers. Cattle were purchased on the Chicago market, December, 1905, and after seventeen days' preliminary feed, divided into three lots which were fed what grain they would readily clean up. Lot I received broken ear corn and clover hay; lot II broken corn and oil meal, shredded fodder (stover) and oat straw; lot III broken corn, shredded fodder and oat straw. Accurate records of weights, gains, feed consumed, bedding, etc., were kept with the idea of publishing the results later. The experiment was completed June, 1906.

In addition to the experimental work the names of 2500 Indiana cattle feeders were obtained by sending circular letters into each county. A list of 100 questions prepared by the Department was sent to these feeders in order to determine the extent of the industry, and obtain a knowledge of the present methods of securing, handling, feeding and marketing beef cattle in Indiana. About 1000 feeders had replied to these inquiries June 30. These replies will be tabulated during the next year and results published. In addition to the questions sent out, several trips of inspection were made in order to study methods of feeding and handling beef cattle, equipment for the business, and the age, quality and condition of cattle in Indiana feed lots. Feeders are manifesting an active interest in the work by letters of inquiry, by inspecting the cattle on feed at the Station, and by answering the list of questions sent them.

No special work has been done with horses, sheep and dairy cattle.

Letters. The Department has given a large amount of time to inquiries from farmers, feeders and agricultural papers. These include all sorts of questions relating to breeding, feeding and management of all kinds of livestock.

Respectfully submitted,

J. H. Skinner.

In Charge Animal Husbandry Department.

Report of Dairy Department.

ARTHUR GOSS, Director.

Sir:—The following is a brief summary of the work conducted by the Dairy Department during the year ending June 30, 1906.

FIELD WORK.

Bi-monthly educational Butter Scoring Contests were conducted throughout the year. The increase in the number of contestants shows that the buttermakers of our state begin to realize the value of these tests. Arrangements have been made to award substantial premiums to the holders of the three highest average annual scores of butter from whole milk plants and from hand separator creameries.

A number of herd tests were conducted for the dairymen throughout the state. The aim is to teach the farmer the value of knowing the annual production and the cost of production of each of his cows, to put dairying on a business basis, to weed out the poor cows, to breed to the good ones and to make dairying more profitable.

Official herd tests were conducted for breeders of full-blood registered dairy cows under the auspices of the Department.

Lectures and talks were given to dairymen and buttermakers in all parts of the state, either collectively in dairy meetings or individually on dairy farms and in creameries.

RESEARCH WORK.

Experiments concerning the relative skimming efficiency of the different systems of creaming as practiced in Indiana were completed and the results are ready for publication.

Experimental work was done to determine the relative overrun from salted and unsalted butter in one of our largest commercial creameries in the northern part of the state.

Tests were made to determine the accuracy of the Babcock test for fat in milk, skim milk, cream, butter, cheese and condensed milk, under varying conditions.

The problem of devising means to quickly and accurately determine the moisture content of butter has also been worked on and is still under investigation.

Circular letters treating various phases of dairying were distributed broadcast and popular articles on important dairy topics were sent to the dairy press.

Respectfully submitted,

O. F. HUNZIKER.

In Charge of the Dairy Department.

Report of the Veterinary Department.

ARTHUR GOSS, Director.

Sir:—For year ending June 30, 1906, the work of the Veterinary Department has been confined largely to the investigation of hog cholera and corn-stalk disease.

Hog Cholera. This disease has been quite prevalent in the vicinity of LaFayette for the past year, and an opportunity for its study was offered. A number of "cholera" herds were visited and the owners directed in regard to the prevention and treatment of the disease. The preventive measures recommended were keeping the hogs under the best sanitary conditions possible and using the necessary precautions against infection from outside sources. In case the herd was diseased, the owner was advised against spreading the infection to neighboring herds. Whenever possible the hogs were given new quarters. Disinfectants were used freely, the animals dipped or sprayed and given a sloppy diet. One ounce of copper sulfate was dissolved in every ten gallons of slop and drinking water fed.

Some difficulty was experienced in getting the owners to follow directions and cooperate in this work. However, the results have been such as to enable us to recommend the above method of treatment to swine raisers. The tar disinfectants and copper sulfate used in the experiments were furnished by the Station.

Laboratory investigation was an important part of this work.

Corn-stalk Disease. During the late fall and early winter an outbreak of corn-stalk disease, that was confined mostly to the north-central portion of the state occurred. About one thousand cases were reported. The disease differed from that occurring in 1901-'02 in that the symptoms were mild, and but few deaths were reported.

In some neighborhoods a larger quantity of moldy corn than usual was left in the fields, and stockmen were of the opinion that the disease was caused by the cattle eating the moldy, rotten corn. In order to test the moldy-corn-theory a few bushels were gathered from a stalk field adjoining one in which the disease had occurred. This was fed to a yearling heifer, and on the sixth day of the test mild nervous symptoms developed.

In addition to the above work tissues and organs from diseased animals were examined, and post mortem examinations held. This was done at the request of stockmen and veterinarians and is an important phase of the work.

Four newspaper bulletins on the following subjects were issued during the year: hog cholera, treatment of lousy live stock, nervous exhaustion and debility in breeding ewes and treatment of stomach worms of sheep.

Respectfully submitted,

R. A. CRAIG, Veterinarian.

Periodicals.

The following periodicals are on file in the Station Library as regular subscription journals:

American Veterinary Review..................New York, N. Y.
Berichte der Deutschen-Botanischen Gessellschaft..........
Berlin, Germany
Botanisches Centrallblatt.............Cassel-Marburg, Germany
Botanische Zeitung..........................Leipsig, Germany
Bulletin de la Societe Botanique de France.........Paris, France
Bulletin de la Societe Chemique de Paris...........Paris, France
Centrallblatt fur Bakteriologie...................Jena, Germany
Chemiker Zeitung...........................Cothen, Germany
The Entomologist...........................London, England
Gardeners' Chronicle ....London, England
Journal of Botany...........................London, England
Journal fur Landwirtschaft.....................Berlin, Germany
Journal of Comparative Medicine and Veterinary Archives....
Philadelphia, Pa.
Journal of the Royal Agricultural Society of England.......
London, England
Journal of the Chemical Society...............London, England
Landwirtschaftlichen Versuchs-Stationen........Berlin, Germany
Live Stock Journal..........................London, England
Oil, Paint and Drug Reporter................New York, N. Y.
Veterinarian................................London, England
Veterinary Journal..........................London, England
Zeitschrift fur Analytische Chemie.........Weisbaden, Germany

Periodicals Donated.

The publishers of the following periodicals have generously sent them free to the Station during the year. These are leading journals and are frequently used by all persons coming in contact with our library:

Agricultural Periodicals.

Agricultural Advertising.........................Chicago, Ill.
Agricultural Experiments...................Minneapolis, Minn.
American Agriculturalist.....................New York, N. Y.
American Farm World........................Augusta, Maine
American Fertilizer..........................Philadelphia, Pa.
American Grange Bulletin...................Cincinnati, Ohio.
American Hay, Flour and Feed Journal........New York, N. Y.
American Sheep Breeder........................Chicago, Ill.

American Swineherd..........................Chicago, Ill.
Beet Sugar Gazette..........................Chicago, Ill.
Blooded Stock...............................Oxford, Pa.
Breeders' Gazette...........................Chicago, Ill.
California Cultivator.......................Los Angeles, Cal.
Chicago Dairy Produce.......................Chicago, Ill.
Chicago Live Stock World....................Chicago, Ill.
Colman's Rural World........................St. Louis, Mo.
Commercial Poultry..........................Chicago, Ill.
Cotton Seed.................................Atlanta, Ga.
Creamery Gazette............................Des Moines, Iowa
Creamery Journal............................Waterloo, Iowa
Dairy and Creamery..........................Chicago, Ill.
Dairy and Produce Review....................San Francisco, Cal.
Dairy Record................................St. Paul, Minn.
Dakota Farmer...............................Fargo, N. D.
Dakota Field and Farm.......................Sioux Falls, S. D.
Deutsche Americkanischer Farmer.............Lincoln, Neb.
Drainage Journal............................Indianapolis, Ind.
Drovers' Journal............................Chicago, Ill.
Elgin Dairy Report..........................Elgin, Ill.
Experiment Station Record...................Washington, D. C.
Farm and Fireside...........................Springfield, Ohio
Farm and Home...............................Chicago, Ill.
Farm and Home Sentinel......................Indianapolis, Ind.
Farm and Live Stock Journal.................Detroit, Mich.
Farm and Stock..............................St. Joseph, Mo.
Farm, Field and Fireside....................Chicago, Ill.
Farm Folks..................................Kansas City, Mo.
Farm, Garden and Poultry....................Hammonton, N. J.
Farm Home...................................Springfield, Ill.
Farm Journal................................Philadelphia, Pa.
Farm Life...................................Chicago, Ill.
Farm News...................................Springfield, Ohio
Farm Poultry................................Boston, Mass.
Farm Press..................................Chicago, Ill.
Farm Progress...............................St. Louis, Mo.
Farm Star...................................Indianapolis, Ind.
Farm, Stock and Home........................Minneapolis, Minn.
Farm Stock Journal..........................Rochester, N. Y.
Farmer and Breeder..........................Sioux City, Iowa
Farmers' Advance............................Chicago, Ill.
Farmers' Call...............................Quincy, Ill.
Farmers' Guide..............................Huntington, Ind.
Farmers' Home...............................Dayton, Ohio

Farmers' Review....................................Chicago, Ill.
Farmers' Sentinel..................................Milwaukee, Wis.
Farmers' Tribune...................................Sioux City, Iowa
Farmers' Voice.....................................Chicago, Ill.
Feather..Washington, D. C.
Field and Farm.....................................Denver, Colo
Flour and Feed.....................................Milwaukee, Wis.
Fruit Grower.......................................St. Joseph, Mo.
Furrow...Moline, Ill.
Grain Dealers' Journal.............................Chicago, Ill.
Hausfreund und Deutsch Amerikanischer Farmer...Lincoln, Neb.
Hoard's Dairyman...................................Ft. Atkinson, Wis.
Holstein-Friesian World............................Ithaca, N. Y.
Home and Farm......................................Louisville, Ky.
Horticultural Visitor..............................Kinmundy, Ill.
Hospodarska Listy..................................Chicago, Ill.
Indiana Farmer.....................................Indianapolis, Ind.
Industrious Hen....................................Knoxville, Tenn.
Inland Farmer......................................Louisville, Ky.
Iowa Agriculturalist...............................Ames, Iowa.
Iowa Homestead.....................................Des Moines, Iowa
Journal of Agriculture.............................St. Louis, Mo.
Kansas Farmer......................................Topeka, Kan.
Kimball's Dairy Farmer.............................Waterloo, Iowa
Lincoln Freie Presse...............................Lincoln, Neb.
Live Stock and Dairy Journal.......................Fresno, Cal.
Live Stock Journal.................................Chicago, Ill.
Live Stock Journal.................................Indianapolis, Ind.
Louisiana Planter..................................New Orleans, La.
Mennonitsche Rundschau.............................Elkhart, Ind.
Metropolitan Rural Home............................New York, N. Y.
Modern Farmer......................................St. Joseph, Mo.
National Farmer and Stock Grower...................St. Louis, Mo.
National Fruit Grower..............................St. Joseph, Mo.
National Stockman and Farmer.......................Pittsburg, Pa.
Nebraska Farmer....................................Lincoln, Neb.
New England Farmer.................................Boston, Mass.
New York Produce Review............................New York, N. Y.
New York Tribune Farmer............................New York, N. Y.
North and South....................................Louisville, Ky.
Northwestern Agriculturist.........................Minneapolis, Minn.
Northwest Horticulturist...........................Tacoma, Wash.
Ohio Farmer..Cleveland, Ohio.
Orange Judd Farmer.................................Chicago, Ill.
Operative Miller...................................Chicago, Ill.

Oregon Agriculturist	Portland, Ore.
Our Horticultural Visitor	Benton Harbor, Mich.
Pacific Dairy Review	San Francisco, Cal.
Pacific Northwest	Portland, Ore.
Pacific Rural Press	San Francisco, Cal.
Poultry Gazette	Clay Center, Neb.
Poultry Husbandry	Waterville, N. Y.
Practical Farmer	Philadelphia, Pa.
Practical Fruit Grower	Springfield, Mo.
Prairie Farmer	Chicago, Ill.
Pure Products	New York, N. Y.
Reliable Poultry Journal	Quincy, Ill.
Rural Advocate	Battle Creek, Mich.
St. Louis Republic	St. Louis, Mo.
Shepherds' Criterion	Chicago, Ill.
Southern Farm Gazette	Starkville, Miss.
Southern Farm Magazine	Baltimore, Md.
Southern Planter	Richmond, Va.
Southern States	Baltimore, Md.
Southwestern Farmer and Breeder	Fort Worth, Tex.
Strawberry Specialist	Kittrell, N. C.
Successful Farming	Des Moines, Iowa.
Swine Breeders' Journal	Indianapolis, Ind.
Trade	Baltimore, Md.
Tri-State Farmer	Chattanooga, Tenn.
Up to Date Farming	Indianapolis, Ind.
Wallace's Farmer	Des Moines, Iowa.
Weekly News Scimitar	Memphis, Tenn.
Up-to-Date Farming	Indianapolis, Ind.
West Virginia Farm Review	Charleston, W. Va.
Wisconsin Agriculturist	Racine, Wis.
Wool Markets and Sheep	Chicago, Ill.

General State Periodicals.

Advertiser	Medaryville, Ind.
American Standard	Frankfort, Ind.
Banner	Bluffton, Ind.
Columbia City Mail	Columbia City, Ind.
Democrat	Salem, Ind.
Enterprise	Wolcott, Ind.
Independent	Rushville, Ind.
Kendallville News	Kendallville, Ind.
LaFayette Commercial Gazette	LaFayette, Ind.
Lowell Souvenir	Lowell, Ind.

Lyons Herald ....Lyons, Ind.
Magnet ....Angola, Ind.
Monterey Sun ....Monterey, Ind.
News ....Monon, Ind.
Progress-Examiner ....Orleans, Ind.
Public Press ....New Albany, Ind.
Recorder ....Rising Sun, Ind.
Register ....Crown Point, Ind.
Ripley Journal ....Osgood, Ind.

FOREIGN PERIODICAL.

Agricultural Gazette of N. S. Wales...........Sidney, Australia.
Co-operative Farming ..'.........................Sussex, N. B.
Farmers' Advocate ....London, Ont.
Journal of Agriculture of Victoria..........Melbourne, Australia.
Journal of the Royal Horticultural Society......London, England.
Natal Agricultural Journal and Mining Record.......Maritzburg
New Zealand Dairyman and Farmers' Union Journal........
Wellington, N. Z.
Station, Farm and Dairy......................Sidney, N. S. W.
Transvaal Agricultural Journal..............Pretoria, S. Africa.
Queensland Agricultural Journal.............Brisbane, Australia.

LIST OF BULLETINS

PUBLISHED BY

The Indiana Agricultural Experiment Station,

To December 1, 1906.

Bulletins of the School of Agriculture.

*Bulletin No. 1, January, 1885, pp. 10, pl. II. The Hessian Fly. By F. M. Webster.

*Bulletin No. 2, January, 1885, pp. 12. Experiments with nitrogenous phosphatic and other fertilizers. By W. C. Latta.

*Bulletin No. 3, April, 1885, pp. 8, pl. III. Insects affecting growing wheat. By F. M. Webster.

*Bulletin No. 4, September, 1885, pp. 12. Experiments with wheat. By W. C. Latta.

*Bulletin No. 5, November, 1885, pp. 12, pl. II. Experiments with small fruits. By James Troop.

*Bulletin No. 6, March, 1886, pp. 16. Experiments with oats and corn. By W. C. Latta.

*Bulletin No. 7, 1886, pp. 12. Commercial fertilizers and notes on agricultural chemistry. By R. B. Warder.

*Bulletin No. 8, August 24, 1886, pp. 16. Experiments with wheat. By W. C. Latta.

*Bulletin No. 9, October 30, 1886, pp. 8, pl. I. The American Meromyza. By F. M. Webster.

*Bulletin No. 10, December 15, 1886, pp. 8. Report of the Director of the Indiana State Horticultural Experiment Station. By James Troop.

*Bulletin No. 11, 1887, pp. 4. Commercial Fertilizers. By R. B. Warder.

*Bulletin No. 12, August 25, 1887, pp. 16. Experiments with wheat. By W. C. Latta.

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*Supply exhausted.

Bulletins of the Purdue University Agricultural Experiment Station.

Bulletin No. 13, January, 1888, pp. 16. Report on new organization. By Pres. J. H. Smart.

Bulletin No. 14, April, 1888, pp. 20. Experiments with oats and corn. By W. C. Latta.

Bulletin No. 15, June, 1888, pp. 14, figs. 9. Concerning the potato tuber. By J. C. Arthur.

*Bulletin No. 16, August, 1888, pp. 12. Experiments with wheat. Crop rotation. By W. C. Latta.

*Bulletin No. 17, November, 1888, pp. 4. Parturient apoplexy. By T. D. Hinebauch.

Bulletin No. 18, January, 1889, pp. 12, pl. I. Experiments with vegetables. By James Troop.

*Bulletin No. 19, January, 1889, pp. 12, figs. 6. Spotting of peaches and cucumbers. By J. C. Arthur.

Bulletin No. 20, January, 1889, pp. 12, figs, 3. I. Experiments in cross fertilization. II. The culture of tropical ferns. By Pierre Van Landeghem.

Bulletin No. 21, February, 1889, pp. 16. How to feed rationally. By C. A. Wulff.

*Bulletin No. 22, March, 1889, pp. 16. Commercial fertilizers. By H. A. Huston.

*Bulletin No. 23, April, 1889, pp. 12. Experiments with corn. By W. C. Latta.

*Bulletin No. 24, May, 1889, pp. 16, fig. I, pl. I. Experiments on milk production. By C. A. Wulff.

*Bulletin No. 25, June, 1889, pp. 18, figs. 3. Entomological experiments. By F. M. Webster.

Bulletin No. 26, July, 1889, pp. 20, figs. 9. Wheat rust. By H. L. Bolley.

*Bulletin No. 27, August, 1889, pp. 12. Field experiments with wheat. By W. C. Latta.

*Bulletin No. 28, September, 1889, pp. 24, figs. 7. Smut of wheat and oats. By J. C. Arthur.

*Bulletin No. 29, December, 1889, pp. 44, plates XIX. Grasses of Indiana. By James Troop.

*Bulletin No. 30, February, 1890, pp. 12, figs. 2. Influenza. By T. D. Hinebauch.

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*Supply exhausted.

*Bulletin No. 31, April, 1890, pp. 22, figs. 13. Experiments with small fruits and vegetables. By James Troop.

*Bulletin No. 32, July, 1890, pp. 22. (1) Treatment of smut in wheat. By J. C. Arthur. (2) Field experiments with wheat. By W. C. Latta. (3) A note on two inferior fertilizers. By C. S. Plumb.

*Bulletin No. 33, October, 1890, pp. 23-54, fig. 1. Small fruits, By James Troop. Entomological notes. By F. M. Webster. The absorptive power of soils. By H. A. Huston and Arthur Goss.

*Bulletin No. 34, vol. II, February, 1891, pp. 55-80. (1) Sugar beets. By H. A. Huston. (2) Field Experiments with commercial fertilizers and manure on barley and oats. By W. C. Latta. (3) Tests of vegetables. By James Troop.

*Bulletin No. 35, March, 1891, pp. 81-108, figs! 2-4. Loose smut of oats. By J. C. Arthur.

*Bulletin No. 36, vol. II, August, 1891, pp. 109-138. (1) Field experiments with wheat. (2) Testing grain. By W. C. Latta. (3) Wheat scab. By J. C. Arthur. (4) Forms of nitrogen for wheat. By H. A. Huston.

*Bulletin No. 37, vol. II, December, 1891, pp. 139-150, (1) Steer feeding. A comparison of cut with uncut clover. By C. S. Plumb. (2) Composition and valuation of Indiana feeding stuffs. By H. A. Huston.

*Bulletin No. 38, vol. III, March, 1892, pp. 29, plate I. (1) Small fruits. (2) Treatment of powdery mildew and black rot. (3) Vegetables. By James Troop.

*Bulletin No. 39, vol. III, April, 1892, pp. 31-62, plates II, III. (1) Field experiments with corn. By W. C. Latta. (2) Sugar beets. By H. A. Huston. (3) Diseases of the sugar beet root. By J. C. Arthur.

*Bulleti No. 40, vol. III, June, 1892, pp. 63-82, fig. 1. The silo and silage in Indiana. By C. S. Plumb.

Bulletin No. 41, vol. III, August, 1892, pp. 83-102. (1) Field experiments with wheat. By W. C. Latta. (2) Forms of nitrogen for wheat. By H. A. Huston.

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*Supply exhausted.

*Bulletin No. 42, vol. III, November, 1892, pp. 103-118, figs. 4. The potato: The relation of number of eyes on the seed tuber to the product. By J. C. Arthur.

*Bulletin No. 43, vol. IV, March, 1893, pp. 20. (a) Field experiments with corn. By W. C. Latta. (b) The sugar beet in Indiana. By H. A. Huston.

*Bulletin No. 44, vol. IV, May, 1893, pp. 21-44, figs. 4. Dairy experiments. By C. S. Plumb.

*Bulletin No. 45, vol. IV, August, 1893, pp. 45-65. Field experiments with wheat. By W. C. Latta. Forms of nitrogen for wheat. By H. A. Huston.

Bulletin No. 46, vol. IV, September, 1893, pp. 66-85, fig. 1. (1) A modification of Grandeau's method for the determiation of humus. (2) Preliminary investigation relating to the determination of "crude fibre." By H. A. Huston and W. F. McBride.

*Bulletin No. 47, vol. IV, November, 1893, pp. 86-101, figs. 2. (1) Does it pay to shelter milch cows in winter? (2) Upon skim milk as a food for calves. By C. S. Plumb.

*Bulletin No. 48, vol. V. January, 1894, pp. 14. Experiments with small fruits. By James Troop.

*Bulletin No. 49, vol. V, March, 1894, pp. 15-40, figs. 3. Sugar beets. By H. A. Huston.

*Bulletin No. 50, vol. V, April, 1894, pp. 41-56. Field experiments with corn and oats. By W. C. Latta.

*Bulletin No. 51, August, 1894, pp. 57-80. (1) Field experiments with wheat. By W. C. Latta and Geo. R. Ives. (2) Forms of nitrogen for wheat. By H. A. Huston.

*Bulletin No. 52, vol. V, November, 1894, pp. 81-113, figs. 4, plates IV. Wild or prickly lettuce. By J. C. Arthur.

*Bulletin No. 53, vol. V. December, 1894, pp. 115-130, figs. 7, plates V, VI. Horticulture and entomology. By James Troop.

*Bulletin No. 54, vol. VI, February, 1895, pp. 8, plates II, fig. 1. New chemical apparatus. By H. A. Huston.

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*Supply exhausted.

*Bulletin No. 55, vol. VI, March, 1895, pp. 9-56, fig. I. Experiments with small fruits. By James Troop. Experiments with corn and oats. By W. C. Latta and George R. Ives.

Bulletin No. 56, Vol. VI, August, 1895, pp. 57-80. Field experiments with wheat. By W. C. Latta and S. P. Carithers. Potato scab and its prevention. By J. C. Arthur.

*Bulletin No. 57, vol. VI. November, 1895, pp. 81-100, figs. 2-6, plates III-IV. The improvement of unproductive black soil. By H. A. Huston.

*Bulletin No. 58, vol. VII, February, 1896, pp. 10. Hog cholera and swine plague in Indiana. By A. W. Bitting.

*Bulletin No. 59, vol. VII, March, 1896, pp. 11-40, plates VIII, figs, 24. Bacteriosis of carnations. By J. C. Arthur and H. L. Bolley.

*Bulletin No. 60, vol. VII, April, 1896, pp. 41-54, plates IX-XIV, figs. 25-31. The American persimmon. By James Troop and O. M. Hadley.

*Bulletin No. 61, vol. VII, August, 1896, pp. 55-70. Field experiments with wheat. By W. C. Latta and W. B. Anderson.

*Bulletin No. 62, vol. VII, October, 1896, pp. 71-96, figs. 32-42. The udder of the cow. By C. S. Plumb.

*Bulletin No. 63, vol. VII, December, 1896, pp. 97-116, plates XV-XVI. Bovine tuberculosis in Indiana. By A. W. Bitting.

*Bulletin No. 64, vol. VIII, April, 1897, pp. 16. Field experiments with corn, oats and forage plants. By W. C. Latta and W. B. Anderson.

Bulletin No. 65, vol. VIII, June, 1897, pp. 17-36, plates II. Formalin for prevention of potato scab. By J. C. Arthur.

Bulletin No. 66, vol. VIII, October, 1897, pp. 37-60, plates III and IV, fig. 1. Indoor lettuce culture. By William Stuart. Condensed edition also, 8 pp.

*Bulletin No. 67, vol. VIII, December, 1897, pp. 61-70. Wheat and corn as food for pigs. C. S. Plumb and W. B. Anderson.

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*Supply exhausted.

Bulletin No. 68, vol. IX, March, 1898, pp. 32, figs. 13. The sugar beet in Indiana. By H. A. Huston and J. M. Barrett.

Bulletin No. 69, vol. IX, March, 1898, pp. 33-40. Insecticides, fungicides and spraying. By James Troop.

*Bulletin No. 70, vol. IX, 1898, pp. 41-52, figs. 14-16. The relation of water supply to animal diseases. By A. W. Bitting.

Bulletin No. 71, vol. IX, June, 1898, pp. 53-64. I. Corn meal and shorts as food for pigs. By C. S. Plumb and W. B. Anderson. II. Skim-milk as food for young chickens. By W. B. Anderson.

Bulletin No. 72, vol. IX, August, 1898, pp. 65-76. Field experiments with wheat. By W. C. Latta and W. B. Anderson.

Bulletin No. 73, vol. IX, October, 1898, pp. 77-92, figs. 17-19. Tests of strawberries, raspberries, blackberries, grapes. By James Troop.

Bulletin No. 74, vol. IX, November, 1898, pp. 93-100, figs. 20, plates I-VI. A native white bedding plant. By J. C. Arthur.

*Bulletin No. 75, vol. X, January, 1899, pp. 1-20, fig. 1. The sugar beet in Indiana in 1898. By H. A. Huston and A. H. Bryan.

*Bulletin No. 76, vol. X, March, 1899, pp. 21-28. Skim milk as a food for young growing chickens. By W. B. Anderson.

Bulletin No. 77, vol. X, March, 1899, pp. 29-44. Field experiments with corn. By W. C. Latta and W. B. Anderson.

*Bulletin No. 78, vol. X, May, 1899, pp. 45-52. Figs. 2-4. The San Jose and other scale insects, and the Indiana nursery inspection law. By James Troop.

Bulletin No. 79, vol. X, June, 1899, pp. 53-62. Roots as food for pigs. By C. S. Plumb and H. E. Van Norman.

Bulletin No. 80, vol. X, September, 1899, pp. 63-76, figs. 5-12. Sheep scab. By A. W. Bitting.

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*Supply exhausted.

Bulletin No. 81, vol. X, December, 1899, pp. 77-92. Field tests with fertilizers on heavy clay lands. By H. A. Huston.

Bulletin No. 82, vol. X, March, 1900, pp. 93-106. Roots and other succulent foods for swine. By C. S. Plumb.

Bulletin No. 83, vol. X, August, 1900, pp. 107-114. Test of small fruits. By James Troop.

Bulletin No. 84, vol. X, September, 1900, pp. 115-142, plates III, graphic charts III. Growing lettuce with chemical fertilizers. By William Stuart.

Bulletin No. 85, vol. X, October, 1900, pp. 143-150. Chrysanthemum rust. By J. C. Arthur.

Bulletin No. 86, vol. X, December, 1900, pp. 151-158. On the amount of water in slop fed fattening pigs. By C. S. Plumb and H. E. Van Norman.

Bulletin No. 87, vol. XI, March, 1901, pp. 1-26. Formalin as a preventative of oats smut. By William Stuart.

Bulletin No. 88, vol. XI, March, 1901, pp. 27-38. Systems ot cropping with and without fertilization. By W. C. Latta and J. H. Skinner.

Bulletin No. 89, vol. XI, July, 1901, pp. 39-69. The production and delivery of milk in cities. By A. W. Bitting.

Bulletin No. 90, vol. XI, October, 1901, pp. 70-82. Tankage as a food for pigs. By C. S. Plumb and H. E. Van Norman.

Bulletin No. 91, vol. XI, January, 1902, pp. 83-106. Fig. 2-5. The modern silo. By C. S. Plumb.

Bulletin No. 92, vol. XI. April, 1902, pp. 101-116. Fertilizer tests on tomatoes. By H. A. Huston.

Bulletin No. 93, vol. XI, June, 1902, pp. 117-123. The influence of condimental stock food in fattening swine. By C. S. Plumb.

Bulletin No. 94, vol. XII, February, 1903, pp. 1-88. Illustrations 15. Diseases of sheep. By A. W. Bitting and R. A. Craig.

Bulletin No. 95, vol. XII, March, 1903, pp. 1-31, Plates I-IV, Figs. 1-5. The improvement of unproductive black soils. By H. A. Huston.

*Bulletin No. 96, vol. XII, July, 1903, pp. 1-36, Figs. 1-8. The care of milk and butter making on the farm. By H. E. VanNorman.

Bulletin No. 97, vol. XII, October, 1903, pp. 37-42. On the value of distillery dried grains as a food for work horses. By C. S. Plumb.

Bulletin No. 98, vol. XII. January, 1904, pp. 43-56. Fig. 1, plates I-VI. Three edible toadstools. By J. C. Arthur.

Bulletin No. 99, vol. XII, March, 1904, pp. 57-68. Tests of small fruits. By James Troop.

Bulletin No. 100, vol. XII, September, 1904, pp. 69-204. Illustrations 23. Diseases of swine. By R. A. Craig and A. W. Bitting.

Bulletin No. 101, vol. XII, February, 1905, pp. 205-219. Alfalfa in Indiana. By A. T. Wiancko and M. L. Fisher.

Bulletin No. 102, vol. XII, March, 1905. pp. 220-254. Illustrations 8. Apple growing in Indiana. By J. Troop.

Bulletin No. 103, vol. XII. March, 1905, pp. 255-264. Rapid method of removing smut from seed oats. By J. C. Arthur.

*Bulletin No. 104, vol. XII, March, 1905. pp. 265-274. Illustrations 2. A simple alkali test for ripeness of cream. By H. E. Van Norman.

*Bulletin No. 105, vol. XII. March, 1905, pp. 275-322. Illustrations 14. Corn improvement in Indiana. By A. T. Wiancko.

Bulletin No. 106, vol. XII. May, 1905, pp. 52. Maps 1. Commercial fertilizers. By Arthur Goss and W. J. Jones, Jr.

Bulletin No. 107, vol. XIII. July, 1905, pp. 12. Agriculture at Purdue University. By Pres. W. E. Stone.

Bulletin No. 108, vol. XIII, July, 1905, pp. 13-32. Illustrations 4. Soy beans, middlings and tankage, as supplemental feeds in pork production. By J. H. Skinner.

Bulletin No. 109, vol. XIII, November, 1905. pp. 33-76. Illustrations 28. Examination of horses for soundness. By A. W. Bitting and G. H. Roberts.

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*Supply exhausted.

Bulletin No. 110, vol. XIII, January, 1906. pp. 77-120. Illustrations 15. Corn Improvement. By A. T. Wiancko.

Bulletin No. 111, vol. XIII, March, 1906, pp. 121-134. Indiana plant diseases in 1905. Frank D. Kern.

Bulletin No. 112, vol. XIII, April, 1906. pp. 135-208. Maps 1. Commercial fertilizers. By Arthur Goss and W. J. Jones, Jr.

Bulletin No. 113, vol. XIII, June, 1906. pp. 208-288. Illustrations 20. Characteristics of some of the contagious and infectious stock diseases. By A. W. Bitting and G. H. Roberts

Bulletin No. 114, vol. XIII, August, 1906. pp. 289-308. Illustrations 1. Winter wheat. By A. T. Wiancko and M. L. Fisher.

FINANCIAL STATEMENT.

Treasurer's Report.

Receipts for Experiment Station Funds:

Balance from Miscellaneous fund, June 30, 1905 -	$ 3,306.12
From United States Treasurer for year ending June 30, 1906. - - - - - - -	15,000.00
From State Treasurer, for year ending Oct. 31, 1906.	25,000.00
From Miscellaneous receipts, for year ending June 30, 1906 - - - - - - - - -	14,657.45
Total - - - - - - - - -	$57,963.57

James M. Fowler,
Treasurer Board of Trustees.

Secretary's Report.

Government Hatch Fund, for the Year Ending June 30, 1906.

	Dr.	Cr.
Received from U. S. Treasurer - -	$15,000.00	
Salaries - - - - - - - -		$ 8,357.04
Labor - - - - - - -		2,152.08
Publications - - - - - - -		1,877.22
Postage and stationery - - - -		554.05
Freight and express - - - - -		79.90
Heat, light, water and power - -		156.88
Chemical supplies - - - - - -		148.92
Seeds, plants, and sundry supplies -		651.44
Fertilizers - - - - - - -		.00
Feeding stuffs - - - - - -		.00
Library - - - - - - -		121.12
Tools, implements and machinery -		636.85
Furniture and fixtures - - - - -		64.50
Scientific apparatus - - - - -		.00
Live stock - - - - - - -		.00
Traveling expenses - - - - -		88.88
Contingent expenses - - - - -		15.00
Buildings and repairs - - - - -		96.12
Total - - - - - - -	$15,000.00	$15,000.00

State Funds, for the Year Ending October 31, 1906.

	Dr.	Cr.	
Rec'd from the State Treasurer	$25,000.00		
General			
Salaries		$ 1,061.31	
Labor		222.26	
Publications		1,192.24	
Postage, stationery and printing		448.70	
Freight, express and drayage		101.47	
Chemical supplies		2.46	
Seeds, plants and sundry supplies		491.08	
Feeding stuffs		1,865.00	
Library		5.00	
Tools, implements and machinery		867.04	
Furniture and fixtures		809.30	
Scientific apparatus		390.10	
Live stock		1,120.00	
Traveling expenses		551.52	
Contingent expenses		11.00	
Buildings and repairs		861.52	
			$10,000.00
Live Stock Feeding			
Salaries		$ 1,046.68	
Labor		238.50	
Postage, stationery and printing		158.72	
Freight and express		38.70	
Seeds, plants and sundry supplies		41.62	
Feeding stuffs		1,039.31	
Tools, implements and machinery		295.47	
Furniture and fixtures		36.00	
Live stock		1,445.33	
Traveling expenses		70.52	
Contingent expenses		.54	
Buildings and repairs		588.61	
			$ 5,000.00
Carried forward	$25,000.00		$15,000.00

Summary of Total Receipts and Expenditures of the Station.

Hatch and Miscellaneous Funds for the Year Ending June 30, 1906; State Funds for the Year Ending October 31, 1906.

	Dr.	Cr.
Balance from year previous - - -	$ 3,306.12	
Rec'd from U. S. Gov. Hatch fund - -	15,000.00	
Rec'd from State, Agricultural Experiment fund - - - - - - -	25,000.00	
Other receipts, Miscellaneous fund - -	14,657.45	
Salaries - - - - - - -		$21,759.74
Labor - - - - - - - -		4,138.04
Publications - - - - - -		4,116.17
Postage and stationery - - - -		2,847.99
Freight and express - - - -		878.52
Heat, light, water and power - - -		290.03
Chemical supplies - - - -		2,444.12
Seeds, plants and sundry supplies - -		3,179.19
Fertilizers - - - - - - -		.00
Feeding stuffs - - - - - -		2,904.31
Library - - - - - - -		150.84
Tools, implements and machinery - -		2,221.96
Furniture and fixtures - - - -		1,272.10
Scientific apparatus - - - -		788.80
Live stock - - - - - - -		2,565.33
Traveling expenses - - - -		4,079.37
Contingent expenses - - - -		263.23
Buildings and repairs - - -		1,984.09
Balance - - - - - - -		2,079.74
Total - - - - - - -	$57,963.57	$57,963.57

The foregoing is a correct statement of expenditures from the Hatch and Miscellaneous funds for the year ending June 30, 1906, and from the State funds for the year ending October 31, 1906.

Edward A. Ellsworth,
Secretary Board of Trustees.

PURDUE UNIVERSITY

Twentieth Annual Report

OF THE

AGRICULTURAL EXPERIMENT STATION

LAFAYETTE, INDIANA.

For the Year Ending June 30, 1907

LaFayette, Indiana
Press of Burt Wilson-Haywood Co.
1908

PURDUE UNIVERSITY

Twentieth Annual Report

OF THE

AGRICULTURAL EXPERIMENT STATION

LAFAYETTE, INDIANA

For the Year Ending June 30, 1907

LaFayette, Indiana
PRESS OF BURT-WILSON-HAYWOOD CO.
1908

To the Governor:

I transmit herewith the annual report of the Purdue University Agricultural Experiment Station for the year ending June 30, 1907.

ADDISON C. HARRIS,
President of the Board of Trustees.

January 1, 1908.

To the President of the Board of Trustees:

I herewith present the twentieth annual report of the Agricultural Experiment Station of Indiana for the year ending June 30, 1907, the same being required by Section 3, of an act entitled "An act to establish Agricultural Experiment Stations in connection with the Colleges established in the several States, under provisions of an act approved July, 1862, and of the acts supplemental thereto," and being in accordance also with the instructions of the Department of Agriculture.

This report consists of a report of the Director, a summary of investigations by members of the Staff, a list of the bulletins published prior to January 1, 1908, and a financial report of the Secretary of the Board of Trustees.

WINTHROP E. STONE,
President.

January 1, 1908.

BOARD OF CONTROL.

STATION STAFF.

ADVISORY COMMITTEE.

UNDER LEGISLATIVE ACT OF 1905.

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TWENTIETH ANNUAL REPORT

OF THE

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION.

FOR THE YEAR ENDING JUNE 30, 1907.

TO PRESIDENT W. E. STONE:

Sir:—I take pleasure in submitting herewith the Twentieth Annual Report of the Indiana Agricultural Experiment Station. This includes the report of the Director, a summary of the work of the different departments, a list of periodicals received, a list of all bulletins published prior to January 1, 1908, a financial statement of the receipts and expenditures from the Hatch, Adams and Miscellaneous funds for the year ending June 30, 1907, and a financial statement of the State Agricultural Experiment fund for the year ending September 30, 1907.

Very respectfully,

ARTHUR GOSS,

Director.

Report of the Director.

The work of the Station during the year covered by this report has with several important exceptions mentioned elsewhere, proceeded along the same general lines as heretofore. Many valuable results have been secured, and it is believed that the work as a whole will compare very favorably indeed with that of any other year in the history of the Station. The activity of the Station is indicated, among other things, bv the fact that almost twice as many bulletins and circulars were published as during any previous year.

In the Agricultural and Chemical Departments, the crop and soil improvement work has been actively prosecuted and considerably extended during the year. This work is yielding results of high value to the farmers of the State and is being appreciated by them to a greater and greater extent as indicated by the increased interest manifest.

In the Animal Husbandry Department several successful feeding experiments on a large scale have been conducted, which have aroused much interest among the feeders of the State. In the Hor-

ticultural Department co-operative orchard and melon work has been conducted in a number of places, which will undoubtedly prove of great benefit to the fruit and melon growers of the State.

In the State Chemist's Department a very important addition was made to the work during the year in the Stock Food Control law enacted by the last Legislature, which this department of the Station was called upon to administer. This will more than double the work of this department. The fertilizer control work has been actively pushed during the year, as heretofore.

An important addition was also made in the Dairy Department by the establishment of a research laboratory for the purpose of making experimental studies of various problems confronting the dairymen and butter makers of the State. The work of the Dairy Department has been very active during the year, as can be seen by referring to the report of this department.

The increased funds due to the Government Adams act has made possible the active prosecution of the plant rust investigation in the Botanical Department, and the hog cholera work in the Veterinary Department. These lines of original research occupy practically all the time of these departments.

The extension work has been very active during the year and has brought the work of the Station strikingly to the attention of a large number of the people of the State. This work has taken the form of exhibits at the State Fair and elsewhere, special trains for the purpose of projecting particular lines of work, and lectures before institutes and other farmers' meetings.

A full account of the work of the Station will be found under the reports of the different departments and no more need be said concerning the same at this time.

Station Building Appropriation.

One of the most important events in the history of the Station during the year was the appropriation passed at the last session of the Legislature for the erection of a new Station building. The $100,000 appropriated for this purpose will make possible the erection of a commodious, well constructed building, admirably adapted to the growing needs of the Station.

The new building is to be of Colonial brick with stone trimmings, and is to have a tile roof. The floors are to be of concrete and the stairs of iron with slate treads, thus making the building fire proof throughout. It is to be two stories in height over a basement, and is to have a frontage of 200 feet, with wings extending to the rear at either end, one 68 feet and the other 20 feet. It is to be located immediately in the rear of the old building, which is to be removed as soon as the new building is completed. The site of the old building is to be converted into a lawn, which it is believed will very materially add to the general appearance of the grounds. The

new building when completed, will be the largest on the University campus, and one of the largest in the country devoted exclusively to Experiment Station work.

Feeding Stuff Control Law.

Another very important event in the history of the Station during the year was the passage by the Legislature of the Feeding Stuff Control law, the administration of which was placed in charge of the Station. It is believed that this is one of the most important pieces of Legislation for the farmers and feeders of the State, as well as the manufacturers and dealers in feed stuffs, that has been enacted in years.

Before the passage of this act, practically all the leading States of the Union, including our neighboring states, had feeding stuff laws, while Indiana did not. The result of this was, that a large amount of inferior and adulterated feeding stuff that could not be marketed elsewhere was dumped on the Indiana market, and sold to the feeders of the State at prices very much above the real value of the material. While this may have been a desirable state of affairs for the corn cob and rice hull mills, it certainly was not to the advantage of the farmers and feeders of the State, and neither was it to the advantage of the millers and manufacturers of high grade and unadulterated feed, as it placed their product in competition with low grade, adulterated material that could be sold at a lower price and still bring an enormous profit. The new law should result in placing the traffic in feeding stuff in the State on a business basis by making it possible for both dealers and consumers to know exactly what they are buying and selling.

Some of the more important provisions of the law and the administration of the same are as follows:

1. Before any feeding stuff covered by the law, can be legally sold in the State, a certificate must be filed with the State Chemist, showing the name of the manufacturer, the name of the feed, the materials from which the feed is compounded, and the nutritive value of the same as shown by the percentage of protein and fat contained.

2. The above facts, set forth in the certificate, are printed on tags, which are furnished by the State Chemist and which must be delivered by the dealer to the consumer with each quantity of feeding stuff sold. The tags also show the number of net pounds in the package.

3. Samples of the different feeding stuffs on sale in the State, are collected on the market by the State Chemist and analyzed. The results of the analyses of the samples collected are published annually in bulletin form, together with the composition of the same samples guaranteed by the manufacturers. By referring to the bul-

letin it can readily be seen which manufacturers are holding their products up to the guaranteed composition and which are not. These bulletins are sent to the Station mailing list and can be had by any farmer or feeder or manufacturer or dealer in feed stuff in the State.

4. Penalties are provided in the law for selling without tags, for adulterating without naming the adulterating materials used, and for guaranteeing smaller percentages of nutrients than are actually present.

A full text of the law and regulations concerning the administration of the same will be found in Circulars 6 and 7 of the Station.

The large addition to the work of the State Chemist's office incident to the administration of the Feeding Stuff Control has necessitated the employment of several additional persons. In this connection, two traveling inspectors have been added to the force. It is the duty of these men to secure samples of the feeds on sale in the State and see that the provisions of the law are being complied with.

The analysis of the samples collected by the inspectors has necessitated the addition of two chemists to the force, and a helper whose duty it is to grind and prepare samples for analysis and take care of other similar matters.

The large addition to the correspondence and clerical work has also necessitated the employment of additional help in the office. Altogether there are at present seven persons engaged in the Feeding Stuff Control work, namely—the State Chemist, two assistant chemists, two inspectors, one helper and one stenographer and typewriter.

It became apparent very soon after the law became operative that some time would have to be given millers and dealers to have analyses made for the purpose of making guarantees of composition, to register brands, secure tags and otherwise get ready to comply with the law. The State Chemist therefore notified those interested that they would be given until July 1 for this purpose. Even by that time, however, the registration was far from complete, but as practically every one was apparently making an honest effort to comply with the law as rapidly as possible, it was decided to file no prosecutions until every one should have had ample time for that purpose.

As it was impossible to do more than get the law started during the year ending June 30, 1907, which is the period covered by this report, no further report concerning the same can be made at this time. In the next annual report of the Station a detailed statement will be made of the Feeding Stuff Control work, including a statement of the receipts and expenditures to June 30, 1908.

Correspondence and Mailing List.

The correspondence and mailing list have both increased considerably during the year. The correspondence and other clerical work in the Station has grown so rapidly during the last three or four years that the services of five stenographers and typewriters are now required to take care of the same. The growth of the mailing list during the same period is shown in the following table:

	1903-4	1904-5	1905-6	1906-7
Names of persons in Indiana.......	7,227	8,254	11,169	11,957
Names of persons outside the State..	1,539	2,211	2,959	3,148
Names of persons in foreign countries	196	197	240	267
Indiana periodicals................	600	589	686	673
Outside state periodicals in U. S...	154	160	129	154
Periodicals (foreign)	8	15	9	9
	9,724	11,426	15,192	16,208

Publications During the Year.

During the year covered by this report, nine regular bulletins were issued besides seven circulars and eight press bulletins. This is considerably the largest number of publications ever issued by the Station in a single year.

An important addition was made to the publications of the Station this year in the Circular series started for the first time. This series is intended to accommodate material of a somewhat more popular and timely character than that usually published in the form of bulletins. Circulars are issued by a number of stations, and it is believed that they will fill a long felt need in the Indiana Station.

The following is a list of the publications issued during the year ending June 30, 1907. A complete list of all regular bulletins and circulars published prior to January 1, 1908, will be found elsewhere in this report.

Bulletins During Year Ending June 30, 1907.

Bulletin No. 114, vol. XIII, August, 1906, pp. 289-308. Illustrations 1. Winter wheat. By A. T. Wiancko and M. L. Fisher.

Bulletin No. 115, vol. XIII, December, 1906, pp. 309-337. Illustrations 7. Steer feeding. By J. H. Skinner and W. A. Cochel.

Bulletin No. 116, vol. XIII, December, 1906, pp. 338-364. Illustrations 11. The hand separator and the gravity systems of creaming. By O. F. Hunziker.

Bulletin No. 117, vol. XIII, February, 1907, pp. 365-394. Maps 1. Results of co-operative tests of varieties of corn, wheat, oats, soy beans and cow peas. By A. T. Wiancko.

Bulletin No. 118, vol. XIII, March, 1907, pp. 395-433. Illustrations 14. How to control the San Jose scale and other orchard pests. By James Troop and C. G. Woodbury.

Bulletin No. 119, vol. XIII, March, 1907, pp. 424-436. Illustrations 1. Indiana plant diseases in 1906. By Frank D. Kern.

Bulletin No. 120, vol. XIII, March, 1907, pp. 437-460. Illustrations 7. Soy beans, cow peas and other forage crops. By A. T. Wiancko and M. L. Fisher.

Bulletin No. 121, vol. XIII, May, 1907, pp. 461-538. Maps 1. Commercial fertilizers. By W. J. Jones, Jr., and O. C. Haworth.

Bulletin No. 122, vol. XIII, June, 1907, pp. 539-554. Alfalfa in Indiana. By A. T. Wiancko.

Report—Nineteenth, July 1, 1905, to July 1, 1906, pp. 62. By Arthur Goss, Director.

Press Bulletins.

No. 130, July 27, 1906. The prevention of transmissible diseases of swine. By R. A. Craig.

No. 131, August 3, 1906. The control of hog cholera. By R. A. Craig.

No. 132, August 10, 1906. Results of variety tests of winter wheat. By M. L. Fisher.

No. 133, September 1, 1906. Fertilizers for wheat. By Arthur Goss.

No. 134, September 21, 1906. The San Jose scale. By C. G. Woodbury.

No. 135, November, 1906. Glanders in horses. (From Bulletin No. 113.)

No. 136, February, 1907. Results of tests of varieties of oats. By A. T. Wiancko.

No. 137, June, 1907. The control of hog cholera. By R. A. Craig.

Circulars.

No. 1. October, 1906, pp. 1-13. Illustrations 2. Hints on preparing for and holding local corn shows. By A. T. Wiancko and M. L. Fisher.

No. 2. November, 1906, pp. 1-14. Illustrations 10. The selection, preservation and preparation of seed corn. By A. T. Wiancko and G. I. Christie.

No. 3. December, 1906, pp. 1-10. Corn stalk disease. By R. A. Craig.

No. 4. January, 1907, pp. 1-10. Illustrations 5. The Experiment Station building. By Arthur Goss.

No. 5. December, 1906, pp. 1-4. Report of experimental work on the Randolph county farm. By G. I. Christie.

No. 6. April, 1907, pp. 1-10. The feeding stuff control law. By Arthur Goss and W. J. Jones, Jr.

No. 7. April, 1907, pp. 1-14. Additional information concerning the feeding stuff control law. By Arthur Goss and W. J. Jones, Jr.

Changes in the Station Staff.

The following changes occurred in the staff of employees during the year:

On September 1, Mr. C. G. Woodbury, M. S., a graduate of the Michigan Agricultural College, was appointed Assistant Horticulturist.

On September 1, Mr. R. E. Stone was appointed Assistant Botanist. He served in this capacity until June 30, at which time he resigned.

On February 1, Mr. George W. Spitzer, Ph. G., who had previously been employed by the University and Station in another capacity, was placed in charge of the chemical work in the Dairy Department under Professor Hunziker's direction, and given the title of Dairy Chemist.

On March 1, Mr. M. B. Porch, who had been serving as Assistant Chemist in Fertilizer Control work, resigned to accept a more remunerative position elsewhere. This position was filled on March 7, by the appointment of Mr. E. G. Proulx, B. S., of the Massachusetts Agricultural College.

On June 1, Mr. H. D. Wendt, who has been serving as Dairy Field Assistant, resigned. This place was not filled until after July 1.

NEEDS OF THE STATION.

One of the most urgent needs of the Station at the present time is a fund to strengthen the work of the Horticultural Department, and enable it to actively extend its work to different parts of the State, as has been made possible with such excellent results in the Agricultural, Dairy and other departments of the Station, by the special appropriations passed by the Legislature two years since.

The five thousand dollar appropriation for the soil and crop improvement work should also be increased, as this has to be divided between two different departments, and is not sufficient to support the work in the way it should be supported.

The Animal Husbandry Department should also have an increased appropriation to provide for much needed expansion in the work of this department, and this is also true of the work of the Dairy and Extension departments.

Respectfully submitted,

ARTHUR GOSS, Director.

Report of the Agricultural Department.

ARTHUR GOSS, Director.

Sir:—I beg to present the following brief account of the work of the Agricultural Department, for the year ending June 30, 1907:

The field experimental work conducted on the University Farm was continued along the same general lines as during the preceding year, expansion or the taking up of new work being practically prohibited by lack of room. The various crop rotation experiments, with and without fertilization, continue to yield interesting results, and some valuable data will be available for publication in the near future. In the testing of varieties of grain and forage crops the object has been, as heretofore, to test new and promising varieties that come to the notice of the Department beside standard varieties of the same crop, to determine their relative merits. In this work varieties are usually given five years to establish a record of their yielding power and important characteristics, after which they are dropped, unless of especial value and desired for co-operative tests among farmers or for the work of breeding still better varieties. Through these variety tests some valuable new varieties of common crops have been discovered, and are being introduced into general use by means of small co-operative tests, including four or five of the most promising varieties among interested farmers throughout the State. Among the newer things, a hardy variety of winter barley has been developed. This began with five or six plants which lived through the winter of 1903-04 on a twentieth acre plot, sown at the same time as the winter wheat of that season. In the last two seasons this variety of barley has given more than double the yields secured from the best of the spring barleys tested. A variety of winter rye has also been found which promises to give a large increase in yield over the common sorts. In the same way, a superior variety of soy beans has been discovered. The latter crop, together with the cow pea, is rapidly finding favor among the farmers of the State, and by its tests, the Station can lend valuable assistance in pointing the way to the better varieties. Tests of varieties of winter oats have again resulted in failure, but the effort to secure a hardy sort will be continued.

The interest taken by the farmers of the State in the co-operative testing of promising varieties of field crops continues to grow, and in all lines more offers to co-operate were received than could be made use of with the limited stocks of seed available. Seven hundred and thirty-nine such experiments on over seven hundred farms were put in operation during the year, and were distributed among the various crops as follows: 75 tests of five varieties of winter

wheat, 61 tests of late summer sown alfalfa, 55 tests of five varieties of oats, 415 tests of four to five varieties of corn, 62 tests of four varieties of soy beans, and 71 tests of four varieties of cow peas.

Considerable attention has been given to cultural methods in the production of soy beans and cow peas, and it has been found that thin planting in rows, using twenty to thirty pounds of seed per acre, and cultivating the growing crops, is much more profitable than sowing three or four times as much seed broadcast without cultivation, as has been the practice among farmers trying to raise these crops. The experiments conducted along this line by the Station indicate that in many of the cases where failures were reported the fault was not in the crop itself, but in the cultural methods adopted for its production. The corn cultural experiments begun last year in Hamilton county are being continued on a somewhat larger scale, and promise to yield some valuable data concerning the various types of corn cultural implements and their use in tending a corn crop.

In the field crops breeding work, most attention has been given to the improvement of corn and wheat, as heretofore. Seventeen regular corn breeding plots under control of the Station are now being conducted in several important corn growing centers in the State where suitable conditions could be found. Plots are thus far located in Porter, Wells, Huntington, Cass, Randolph, Johnson, Morgan, Greene, Vigo and Tippecanoe counties. On most of the plots the main object is to develop a suitable type of corn for that particular section of the state. In three cases special attention is given to increasing the nitrogen content of the grain. On the University Farm several special lines of corn breeding work are under way. In one plot the main object is to develop a type of dent corn that will produce two or more ears per stalk; in another, the object is to determine the effect of selecting all seed ears from stalks having suckers; and in another, an effort is being made to determine the effect of shape of seed ear upon productiveness and other qualities. Careful records are kept of the characteristics and performance of each ear and row in the several breeding plots, and a large amount of statistical data is being collected which may be expected to shed some further light on the subject of corn improvement.

The work in wheat breeding, which is conducted on the University Farm, was extended this year to include over twenty thousand individuals from over two hundred specially selected and pedigreed parent plants out of the best of last year's centgeners. To accomplish the best results, this line of breeding must be still further extended, and the field work combined with some laboratory and green house work, and it is hoped that it may be possible to provide the necessary equipment in the near future. In a smaller way, sim-

ilar breeding work is being carried on with oats, winter barley, cow peas and soy beans, and will be extended as fast as the necessary labor and facilities for effective work can be made available. The little work it has been possible to do so far, indicates that much good may be accomplished by systematic breeding towards improving the yielding power, quality and hardiness of all of these crops. In the case of the more extensively grown crops, even a small amount of improvement would soon become of vast importance to the agriculture of the State, and it is to be hoped that it may be possible to extend this branch of the Department's work.

Respectfully submitted.

A. T. WIANCKO, Agriculturist.

Report of the Horticultural Department.

ARTHUR GOSS, Director.

Sir:—Following is a statement of the work of the Horticultural Department for the past year:

It has been possible to greatly extend the scope of this work owing to the fact that at the beginning of September, 1906, Mr. C. G. Woodbury was appointed Assistant Horticulturist, and to him was delegated most of the co-operative experimental work which is mentioned further on.

The experiments with orchard and small fruits on the Experiment Station grounds were under my immediate supervision, and have been gradually extended so as to include many more varieties. Owing to the heavy, late spring frosts most of the early blooming varieties were entirely destroyed. This was especially true of eighty varieties of strawberries, and in a lesser degree with the other varieties of small fruits. A few varieties of apples escaped the severe freezing weather and bore good crops of fruit.

An investigation of the melon growing industry of Southern Indiana has been started during the past season. Diseases of watermelons and cantaloupes, varieties, methods of growing, packing and marketing, have been studied with a view of discovering the most effectual remedy for the various troubles that the melon growers have to contend with.

Watermelons were found to be attacked severely by the wilt disease (Neocosmospora vasinfecta var. nivea.) The histories of about 55 fields were obtained for years back. These were carefully studied and the fields observed during the past season. The evidence collected seemed to indicate that the watermelon wilt could be controlled by a long rotation and by not allowing melons to follow melons in the same field oftener than once in six years. It appar-

ently takes about this long for the disease to die out after once infecting a field and if melons follow in less time than that mentioned, on a field in which the disease has appeared, the crop is very liable to serious infection.

The two diseases causing most trouble on the cantaloupe are the wilt and the rust. The former is very similar to the watermelon wilt in its effect, but is caused by a germ (Bacillus tracheiphilus) and fields are liable to infection in which melons have never before been grown. No satisfactory method of control has as yet been developed. The rust annually causes great damage to the cantaloupes, especially about Decker. This is a fungus disease, and from work done this season it seems to be evident that it can be controlled by the 5-5-50 formula of Bordeaux mixture. Four applications of this, kept plants in a fairly healthy condition, while the crop on unsprayed adjacent rows was ruined.

A new so-called rust resistant cantaloupe which has been recently developed by the Colorado Experiment Station, was also tried. Its rust enduring qualities were very marked. The melon was of the Rocky Ford type and of fine quality, but is at a disadvantage in Indiana on account of its lateness. The investigations of different phases of the business will be pursued another season.

Tomatoes.—The work of breeding tomatoes for greater productiveness was continued this season. Complete records were kept of the yield in weight and number of fruits on each plant during the entire period of production. The heaviest yield for a single plant was 30 pounds, nine ounces; the lowest was four pounds, nine ounces or a difference of about 700% in yield of different plants under conditions as exactly similar as they could be made. The greatest number of fruits per single plant was 113, the least 15, or again over 700%. The correlation between greatest number and greatest weight was not exact, however. The importance of fixing the fruit bearing tendency by continued selection, thereby obtaining a much more prolific race of the variety under experimentation, whether it be of tomatoes or other small fruits, can be readily appreciated.

An investigation of the present status of the growing of tree fruits, especially apples, has been undertaken, as a preliminary to more extended co-operative work in the future. Careful records were kept of all operations this season in the care of 18 orchards. Some co-operative spraying was done, especially in the way of testing various new preparations for the control of the San Jose scale. The Rex Lime-Sulphur, Target Brand, Horicum, Scalecide, Tak-a-nap Soap, Thrip Juice, Arseniated Petroleum Emulsion and Crude Oil, were used in comparison with the home made standard lime-sul-

fur wash. A 20% kerosene emulsion made with the Tak-a-nap soap was found to be an effective winter spray for the scale, as was also crude oil. The one, however, is too costly, and the other as used at present seems to be of considerable danger to the trees.

In addition to the above, several minor activities of a more popular nature, received some attention.

The co-operative orchard and melon experiments mentioned above are continuous and so will necessarily have to be carried on for several years before definite conclusions are reached.

Respectfully submitted,

J. Troop, Horticulturist.

Report of the Chemical Department.

Arthur Goss, Director.

Sir:—The following is a brief summary of the work of the Chemical Department for the year ending June 30, 1907:

State Chemist's Work.

The work of the State Chemist was considerably increased by the passage of a concentrated feeding stuff control law similar to the fertilizer control and much time in the past three months has been devoted to explaining the law and endeavoring to acquaint the manufacturer and consumer with its requirements. In addition to the correspondence mentioned the chief deputy explained the law at the meeting of the Indiana Millers' Association at Indianapolis on May 10th and two circulars containing the law and information regarding it have also been published.

Additional information concerning the Feeding Stuff Control law will be found in the Director's report, page 7.

The work of the Fertilizer Control has been carried on as in previous years. Our deputies visited all the counties in the State where fertilizer is sold and secured samples.

Five hundred and fifty-one samples were secured in the fall of 1906 and the results of the analyses of these samples were published in Bulletin No. 121. Three hundred and fifty-four samples were secured in the spring of 1907 and the reports of the analyses will soon be available for distribution to the manufacturer and consumer.

A careful estimate of the sales of fertilizer in 1906 shows that for the year the sales were 13.571 tons in excess of those for 1905,

being 98,571 tons in 1906 as against 86,000 tons in 1905. The remarkable growth of the fertilizer trade in this State is shown by the fact that the State Chemist's estimate of sales in 1897 was only 41,900 tons, an increase of 46,671 tons in 10 years.

The sale of tags indicates that the trade this spring was greater than any previous spring on record.

Six cases of violation of the law were reported to county prosecutors.

The correspondence of this branch of the Department is constantly increasing and since the passage of the Feeding Stuff law has assumed formidable proportions.

The work of the Department is in fine condition and much credit is due the deputies for their interest and efficient work.

Co-operative Work With Other Departments.

In co-operation with other departments of the Station the following work has been done during the year:

Agricultural Department.—The work in corn breeding was continued. Three hundred and fifty-three samples were analyzed, necessitating 706 determinations each of moisture, nitrogen and fat. In addition, complete analyses were made of six samples.

Fifty-nine samples of wheat involving 118 determinations each of moisture, nitrogen, fat and ash were also made for this department.

Dairy Department.—The work detailed in the 1906 report was continued, involving the analysis of the following samples: Buttermilk 3, cheese 2, whey 3, butter 2, milk 3, cream (fat determinations) 32, condensed milk 2, albumen in milk 1, calibration of flasks 22.

Animal Husbandry Department.—For this department the following samples were analyzed: Corn stalks 1, shredded stover 1, clover hay 6, oat straw 1, linseed meal 1, corn and cob meal 1, corn 6, corn cobs 1, cotton seed meal 5, timothy hay 5, silage 5.

Veterinary Department.—The work in co-operation with this department on the testing of corn for a poison notably hydrocyanic acid supposed to be responsible for a disease similar to corn stalk disease was concluded with negative results.

Miscellaneous Analyses.—The following miscellaneous analyses were made during the year: Condimental stock foods 2, bran 4, shorts 1, oat meal 2, sucrene feed 1, mill feed 1, sugar beets 13, arsenic 1, Paris green 3, acid phosphate 1, acidulated bone 2 and cream 1.

Respectfully submitted,

W. J. Jones, Jr., Associate Chemist.

Report of the Soil Improvement Work.

Arthur Goss, Director.

Sir:—As a part of the work of the Chemical Department, the following investigations in soil improvement have been carried on during the year: In this connection the co-operative fertilizer experimental work, that has been in progress for several years, has been continued along very much the same lines as in previous years and extended so as to cover practically every important soil type in the State. During the past year 78 experiments have been conducted in 54 different localities, representing 38 counties and are as follows:

With Corn	33
With Wheat	14
With Oats	3
With Rye	1
With Clover	2
With Timothy	1
With Cow Peas	1
With Onions	5
With Potatoes	15
With Celery	1
With Strawberries	1
With Cherry Trees	1
Total	78

The materials used in making the above mentioned tests were as follows: Dried Blood, Nitrate of Soda, Bone, Acid Phosphate, Dicalcic Phosphate, Rock Phosphate, Muriate of Potash, Sulphate of Potash, Kainit, Ashes, Slaked Lime, Ground Limestone, Magnesium Sulphate, Muck, Clay, Straw, Manure, etc.

The chief object of this work has been to determine whether some element or combination of elements composing these fertilizers could be profitably applied to the various soil types, and if so, the most profitable in any given case. A large number of other problems have been studied in this connection, some of which are as follows:

1. A study of the lasting effect of fertilizer.

2. A comparison of the different forms of nitrogen, phosphoric acid, potash and lime compounds with the view of determining which can be the most economically applied in the various localities.

3. A comparison of commercial fertilizer with manure.
4. A comparison of different sorts of manure.
5. A study of the effects of tiling on clay soil.
6. A comparison of the effects of fertilizer on tiled and untiled land.
7. A study of the injurious effect of fertilizer on the germination of corn.
8. A study of the effects of fertilizer in lessening the injurious effects of bad seasons and insect ravages.
9. A study of the effects of fertilizer on clover following its application.
10. An investigation to determine the most profitable amounts of fertilizer to be used in a given case.
11. A study of the effects of different fertilizers on the quality of the crop.
12. A study of the injurious effects of fertilizers on the soil.
13. A study of the different methods of applying fertilizer.
14. A study of the so-called "bogus" soils of the State with a view of ascertaining why these areas are unproductive.

It is impossible at this time to go into details, but the above will give some idea as to the scope of the work. The results of these tests for the past year have been very gratifying and it is not at all uncommon to find some combination of fertilizer that will produce large increases in yield and handsome profits. In nearly every experiment some combination of fertilizer has been applied that produced economical returns, whereas other combinations very often result in financial loss. This will serve to illustrate the importance of the work in its influence in directing the farmers of the State in an intelligent choice of commercial fertilizer.

It has been attempted to classify the several soils of the State both with reference to their crop producing powers and in respect to their chemical composition. In this connection 73 analyses were made involving 290 determinations, and are as follows:

Soils and sub-soils analyzed	55
Special analyses	18

A comparison of fifth normal hydrochloric and nitric acids as solvents for the more active forms of phosphoric acid and potash in certain soils was made.

A large number of soil samples were tested with litmus paper with a view of determining whether there is any relation between the acidity of soils as indicated by litmus, and the effects of the application of lime to these soils.

In connection with the work on soil improvement 19 samples of

Irish potatoes were analyzed, involving 209 determinations with the following purposes in view:

1. To determine whether potatoes grown in muck soil are inferior in quality to those grown on other types of soil, as is commonly believed.

2. To ascertain what effect the application of different fertilizers has on the composition of the tubers grown in different types of soil.

The first year's work indicated:

1. That it is possible to grow potatoes of good composition and excellent cooking quality on muck soils. This may be due partly to the variety and season, but at any rate the muck grown potatoes tested here this year were in no wise inferior to the other potatoes. If anything they proved to be of better quality. No attempt, however, was made to test their keeping qualities in storage.

2. That the specific gravity method for determining starch in different samples of potatoes tested here would in many cases be so unreliable as to be misleading.

3. That the application of fertilizers affected the composition of potatoes both in the food constituents and in the ash elements. This was more marked in soils which showed a large response in increased production upon the application of fertilizers.

4. That potash seemed to affect the composition of the tubers more markedly than either nitrogen or phosphoric acid or even both combined.

It is intended to continue this work until several years' results are available.

In connection with the potato work the question having been asked as to whether the formaldehyde solution used in the treatment of potatoes to prevent scab suffered any diminution in strength with the amount of potatoes treated it was decided to investigate the subject.

Mr. E. S. Smith, of Westville, Ind., who sought the information very kindly furnished the samples needed for the investigation. The results show that there is an appreciable diminution of the amount of formaldehyde in the solution after a number of potatoes have been treated amounting to a loss of 82.9% of the fomaldehyde in the original solution after the treatment of 14 lots of potatoes of approximately 17 bushels each.

Respectfully submitted,

W. P. Kelley,
Assistant in Soil Improvement.

S. D. Conner,
Assistant Chemist.

Report of the Botanical Department.

ARTHUR GOSS, Director.

Sir:—During the year ending June 30, 1907, the work of the Botanical Department has been largely directed to the study of the various problems connected with the plant rusts, of which the grain rusts are particularly prominent and economically important. The expansion of this line of study has been made possible by an increase of revenue from the Adams fund, which is designed especially for research work. Beside the study of diseases due to rusts, other diseases of plants have received a share of attention, as they have been brought to the notice of the department by correspondents. Some time has also been given to the matter of weeds and their eradication as heretofore, and a few attempts have been made to evolve new methods of extermination. Many inquiries are received from cultivators of the State, and sometimes from other states, for assistance along these several lines, and the correspondence required of the department is necessarily heavy.

For ten months of the year, the department had the assistance of Mr. R. E. Stone, B. S., a graduate of the University of Nebraska, a well informed and assiduous worker, who came in September, 1906, and resigned the last of June, 1907. Mr. E. G. Hagadorn, B. S., a graduate of the Michigan Agricultural College, was appointed in November to give part time to the care of the greenhouse, and to the various plants used as hosts in the rust cultures. Mr. Frank D. Kern continued throughout the year as heretofore to do efficient service as first assistant.

Plant Rusts.—The study of the rusts was continued during the year with increased vigor. As usual the grain, grass and sedge rusts received a large share of attention and considerable time was also devoted to the species affecting the cedar and apple families, alternately, some of which cause the so-called "cedar-apples" and "orchard rusts." Many other species of no immediate economic importance were studied and cultivated with the hope that an insight into their life histories. habits of growth and manner of attack might give some clue to the proper direction in which to seek for methods of control.

The work, thus far, has proceeded chiefly along two important lines, the one, the systematic study of the species, and the other the making of cultures and study of development.

The systematic study involves questions of classification, nomenclature, determinations of the number of valid species, and a drawing up of descriptive accounts of each genus and species. A part

of the systematic work assumed definite form and was published in March, 1907, by the New York Botanical Garden as Part 2, Vol. 7, of the North American Flora, a publication designed to present in one work descriptions of all plants growing, independent of cultivation, in North America. The use of many important herbaria has added to the completeness of the results. Some of these have been loaned while others have been visited. During January some time was most advantageously spent at the New York Botanical Garden in the study of herbarium specimens and in consulting literature not otherwise available.

The culture work, comprising tests of the viability of spores and making the inoculations on live plants in the green houses, is carried on chiefly during the spring months, the normal germination period for the resting spores and the active growing season tor the host plants. Considerable time and effort is spent during the other seasons in the collection of desirable and suitable material for these infection experiments. This is accomplished through correspondents, either in response to suggestion, or upon their own initiative, and through field trips of the members of the department. During this year two important observation and collection trips were undertaken by the Department, one to the vicinity of Lake Forest, Ill., and one to the mountains of Colorado, both yielding notable results.

General Plant Diseases.—Records of the occurence of the more important plant diseases were kept during the year. Much information concerning the distribution and injury was furnished by correspondents in response to a circular letter sent out by this Department. More than 100 replies were received, which formed the chief basis for the survey as given in Bulletin No. 119, issued in March, 1907. This also contained brief notes on the control of plant diseases through cultural methods and fungicides.

Perhaps the most notable single disease was a disturbance in the health of the oat crop. This was characterized by a yellowing and reddening of the outer leaves to such an extent that the fields soon began to look as if they might be badly rusted. Reports of the trouble were common, especially from the northern half of the State, and many feared great losses would result. Investigation showed that the cause of the trouble was not insects, as many suspected, nor any vegetable parasite, but a physiological disturbance brought on by the abnormal and unfavorable weather. It was an effect rarely seen on so large a scale, but one which the continued wet weather in connection with the uniformly low temperature, maintained the year throughout, and an extraordinarily long, late spring, might be expected to produce.

Weeds.—The identification of troublesome weeds and the furnishing of available information concerning the best methods of eradication was carried on to the usual extent. Manuscript for a manual which can readily serve to present the facts in printed form was partially prepared. Spraying experiments for the control of certain weed pests were carried on and an account will be published later when supplemented by further work.

Respectfully submitted,

J. C. ARTHUR, Botanist.

Report of the Animal Husbandry Department.

ARTHUR GOSS, Director.

Sir:—During the year ending June 30, 1907, the work of the Animal Husbandry Department has been confined to a study of beef and pork production and the maintenance of ewes on dry and succulent rations during the winter.

Beef Production.—Bulletin No. 115 on Steer Feeding published December, 1906, has resulted in favorable comment from many feeders and farmers in the State as well as the press throughout the corn belt. This bulletin contains the results of the first cattle feeding experiment conducted by the Station under the provisions of an act, of the Indiana Legislature, in 1905, appropriating $25,000 annually to the Experiment Station, $5,000 of which was appropriated specifically for cattle feeding. This experiment as outlined in the Nineteenth annual report of the Station involved three lots of eleven steers each which were fed on different rations for fattening cattle.

Lot I was fed a ration of broken ear corn and clover hay; lot II broken ear corn, linseed oil meal, shredded stover and oat straw; lot III broken ear corn, shredded stover and oat straw; thus allowing a comparison, 1st of two rations, both of which furnished a nitrogenous feed to the steers, one in the form of roughage (clover hay), the other in the form of a concentrate (linseed meal); 2nd, a comparison of rations which furnished a nitrogenous feed to the steers as in lot I (clover hay) and lot II (linseed meal), with a ration which supplied no nitrogenous feed, lot III, 3rd, a comparison of a ration containing a nitrogenous supplement (lot 1 corn, corn stover, oat straw, linseed meal) with rations containing no supplement (lot II corn, clover hay), (lot III, corn, corn stover and oat straw). The results of this experiment are given on page 331, Bulletin No. 115.

Summary of Results.

The returns from the cattle used in the experiment reported in Bulletin No. 115 made it possible to enlarge the cattle feeding experiments in the fall of 1906. Yards, sheds, tanks, etc., were provided for four additional lots of cattle, thus giving equipment for feeding seven lots of experimental cattle. In addition to this a silo was erected and filled. The work of 1906-07 was planned with the purpose of making a study of the effect of three separate and distinct factors on the finish of the cattle, cost of gains, and profits from feeding cattle as follows:

1. To determine the influence of age on the economy and profit of beef production. Four lots of steers were used, including one lot each of calves, yearlings, two year olds and three year olds, fed on a ration of corn (shelled), cotton seed meal, silage and clover hay.

2. The influence of silage, in the ration, was studied in connection with eight lots of cattle, including in addition to those above, one lot fed corn, silage and clover hay, one lot fed corn and clover hay, and one fed corn and timothy hay and two short fed lots (90 and 60 days) on corn, cotton seed meal, clover hay and silage.

3. The influence of long and short feed on cost of gain and profit. There were two lots of steers fed 90 and 60 days and one lot fed 180 days in this experiment.

The hundred head of cattle involved in this experiment with the exception of yearlings and calves were purchased in southern Indiana in Ripley, Jennings, Lawrence and Orange counties and shipped direct from the pastures to the experimental feeding plant on the University farm. The results of the experiment show, first, that there is a striking difference in the cost of producing a hundred pounds of gain on calves and yearlings, while there is but slight difference in the cost of gains on yearlings, two year olds and three year olds. There was a slight difference in cost in favor of the younger cattle. Second, a ration of corn, cotton seed meal, silage and clover produced a greater daily gain at less cost, and gave better finish and greater profit per steer than any other ration in the test, while corn, clover and silage ranked second in cost of gain and profit per steer, and third, in finish of cattle. Corn and clover hay ranked second in rate of gain and finish and third in profit per steer, while corn and timothy hay proved unprofitable in every way. Third, the heavy steers fed for a short period made a greater daily gain and larger relative profit than the lighter cattle fed for a longer period.

Co-operative Work.—In addition to the experimental cattle feeding done at the Station, the department has co-operated with

two of the most careful cattle feeders in the State in keeping records of feed consumed, gains made, profits, etc.; in one case on 50 head of steers, which were being fed for baby beef, in the other on 20 head of heavy steers fed lightly in winter and finished on grass. This work was inaugurated in order to secure data on the cost of gains and profits in beef production under practical conditions and with the hope of creating an interest and improving the methods among feeders in various localities.

Visits of Inspection.—In this same connection a representative of this department has visited many different feeders in the State for the purpose of studying their equipment and methods of feeding. Special study was made among those feeders who used silage in order to obtain information concerning their methods and conditions of feeding and the results obtained from the use of silage.

A Study of Feeders.—Much useful information has been collected concerning the advantages and disadvantages of purchasing feeders on different markets. Especial attention was given to the study of southern Indiana conditions where large numbers of cattle are annually produced and but few fed for market. This information will be published and distributed in pamphlet form, Circular No. 8, Beef Production 1.

Pork Production.—A number of experiments were conducted to determine the economy of gains and profit in pork production, where different rations were fed. The first of these experiments included three lots of pigs fed as follows:

Lot I shelled corn and skim milk; lot II shelled corn and field peas and oats (pasture); lot III shelled corn and rape (pasture). The results show that a ration of shelled corn to which a nitrogenous supplement in the form of skim milk was added, was more efficient than a ration of shelled corn with the addition of a nitrogenous supplement in the form of a green crop (peas and oats) composed largely of a legume, and that rape was about as efficient as peas and oats when used in connection with shelled corn for pigs.

Two experiments were conducted to determine the relative profit from feeding tankage and oil meal as supplements to corn fed to swine where the same nutritive ratio was used. The results show tankage to be more efficient and profitable as a supplement than linseed oil meal.

The work begun in 1903 to determine the value of soy beans in pork production where pastured off in the field, was continued with a fourth experiment conducted in September, October and November. This experiment involved four lots of pigs.

Further study of the relative value of soy beans as a supplement to corn was made by comparing rations as follows: I. Corn meal

and oil meal. II. Corn meal and soy bean meal. III. Corn meal and middlings.

The results show that corn meal and soy bean meal produced the largest gain. Corn meal and middlings ranked second and corn meal and oil meal third.

In order to secure additional data on this subject a second experiment was conducted in the spring of 1907, in which five lots of pigs were fed rations with about the same nutritive ratio, made up of a combination of feed as follows:

Lot I, corn 8 parts, oil meal 1 part; lot II, corn 7 parts, soy bean meal 1 part; lot III, corn 15 parts, tankage 1 part; lot IV, corn 1 part, middlings 1 part; lot V, corn 1 part, skim milk 1½ part. The results of this experiment showed the ration containing skim milk to be the most efficient in gains produced, corn and middlings ranking second, and tankage third, with corn and soy beans fourth, and but slightly below corn and tankage, while corn and oil meal ranked fifth with 4.02 per cent less gain that the ration of corn and soy bean meal and 12 per cent less gain than was produced by corn and skim milk.

Bacon Hogs.—The work in connection with Yorkshires reported last year was continued with the view of obtaining additional information.

Sheep Feeding.—A study of the importance and value of succulent feed in the winter ration of pregnant ewes was made in an experiment in which one lot of eight ewes received silage in addition to oats and mixed hay and another lot received corn stover in addition to oats and mixed hay. The factors considered were the influence on condition and health of the ewes; influence on weight and vigor of lambs dropped; the influence on milk flow as measured by rate of increase in lambs; the effect on the fleece of ewes and the relative cost of maintenance. This work will require additional experiments to warrant any conclusion.

Respectfully submitted,

J. H. Skinner,
Chief of Animal Husbandry Department.

Report of the Dairy Department.

ARTHUR GOSS, Director.

Sir:—During the year ending June 30, 1907, the scope of work of the Dairy Department was materially enlarged by the establishment and equipment of a Research Laboratory for original investigations in dairying. Mr. Geo. W. Spitzer, of Purdue University, was appointed as Dairy Chemist. This addition has put the department in a position to conduct experiments in connection with the University Creamery and to take advantage of valuable data secured in the extension work. The purpose of this laboratory is to work towards the solution of problems that confront the dairymen and buttermakers of the State in their daily work.

The following is a brief summary of the work conducted by the Dairy Department during the year ending June 30, 1907:

EXTENSION WORK.

Herd Tests.—Systematic herd tests were conducted throughout the year, for Indiana dairymen who desired to have their cows tested regularly and to obtain records of their individual performance. Twenty-six herds representing 355 cows were included in these tests. "Records are kept of the milk and butter fat produced and the feed consumed by each animal, and at the conclusion of the year each dairyman receives a complete report stating the annual production of milk and butter fat, the cost of production and the net returns from each cow. The aim of this work is to emphasize the great need of improving the dairy herd in order to make possible a more economic production of milk." A bulletin is now under way covering the results of these herd tests and giving simple and practical suggestions on the improvement of the dairy herd.

In answer to requests from breeders of pure blood Holstein cows seven official cow tests for entry in the Advanced Registry were also made.

District Associations.—Three district associations (The Eastern Indiana Dairy & Creamerymen's Association; The Northern Indiana Dairy & Creamerymen's Association; The Southern Indiana Dairy & Creamerymen's Association), were organized in the eastern, northern and southern part of the State respectively. These associations were annexed to the State Dairy Association as auxiliaries. The purpose of organizing these forces was to bring the individual dairyman in closer touch with the work of the State Dairy Association and of the Experiment Station, to facilitate the arranging and

holding of dairy meetings where they are most needed, and to diffuse the Dairy Gospel more efficiently throughout the State.

Dairy Instruction and Inspection.—Lectures and talks were given to dairymen and buttermakers in all parts of the State, either collectively in dairy meetings, or individually on dairy farms and in creameries. Seventy-one dairies and creameries were inspected and twenty-five dairy meetings were held.

A Special Dairy Train was run over the Wabash R. R. between Hamilton, Ind., and Westville, Ind. This train was equipped with an engine, exhibition car, two lecture coaches, a diner and a sleeper, and was furnished free for the use of the Experiment Station. Messrs. D. F. Maish, of Frankfort, Ind., and Samuel Schlosser, of Plymouth, Ind., assisted in giving talks. Nine stops were made and 1614 people lectured to.

The success of this one-day-train suggests the desirability of running Dairy Specials over all lines of the State for the purpose of disseminating dairy knowledge.

Educational Butter Scoring Contests.—A series of six educational butter scoring contests was held at the Indianapolis Cold Storage. As the results of the hearty co-operation of and generous contributions from the State Dairy Association and the many dairy supply houses doing business in Indiana, the Dairy Department was able to establish a premium fund amounting to $160. This fund was used exclusively for the purchase of prizes (premium cups) to be awarded to the winners of the three highest average annual scores of creamery butter and dairy butter. Diplomas of merit were offered to the holders of an average annual score of 93 or above in the creamery butter class and 91 or above in the dairy butter class. Mr. H. J. Credicott, U. S. Butter Judge of Chicago, scored the butter at all of the contests. At the conclusion of each contest a report of the score, criticisms and per cent of moisture was mailed to each contestant. These inducements have naturally created much interest and enthusiasm and have helped to swell the number of entries. That these contests are an effective means to interest our dairymen and buttermakers in the production of better milk and better milk products can no longer be questioned, and much good is bound to come from systematic work along this line.

Research Work.

Bulletin No. 116, on "The Hand Separator and the Gravity Systems of Creaming." was issued in December, 1906. Parts of this bulletin have been freely copied and published in different dairv

and agricultural papers. The heavy demand for copies of this publication by dairymen in Indiana and in other states has necessitated the issue of a second edition.

Moisture Content in Butter.—Careful experiments were started for the purpose of determining the extent and causes of variations in the moisture content of butter made under Indiana conditions. Beginning in January, 1907, complete chemical analyses were made of 165 samples of butter submitted to our scoring contests and of 49 samples of butter made at the Purdue Creamery. Although an additional year's work will be necessary to complete these experiments, sufficient data are at hand now to warrant the issue of a preliminary report of the investigations already made. The following is a brief summary of the conclusions drawn:

1. The per cent of moisture in butter varies greatly with butter made in different localities and under apparently identical conditions.

2. Butter made in spring and early summer almost invariably contains more moisture than fall and winter butter.

3. In some localities difficulty is experienced during spring and early summer to keep the moisture content of butter below the legal maximum (16%).

4. The butter analyses showed an increase in the per cent of soft fats and a decrease in the per cent of hard fats towards spring and early summer. The per cent of volatile fats remained practically unchanged.

5. If the soft and hard fats are separated and shaken or churned separately with equal amounts of water and under identical conditions, the soft fats, upon hardening, will contain about twice as much moisture as the hard fats.

6. The above facts suggest that the excess of soft fats usually present in spring milk has the tendency of increasing the per cent of moisture in butter in spring and early summer.

7. The results further show that, in the majority of creameries in Indiana, the moisture content is lower than necessary, which is largely due to the fact that our buttermakers do not use any moisture test. A low moisture content means a small overrun. The profits of many of our creameries could be increased materially without overstepping the 16% limit, by paying closer attention to the moisture problem.

The financial importance of this problem to the dairy interests is sufficient to warrant a continuation of these experiments.

Pasteurization and Percent of Fat in Buttermilk.—Investigations have been started to determine the effect of pasteurization of cream at different temperatures on the per cent of fat lost in the buttermilk, with special reference to sour gathered cream. Definite data of this phase of butter making are lacking and will serve as a valuable guide in creameries where butter is made from pasteurized cream.

Correspondence.—In answer to inquiries by mail, information on all lines of dairying was given through private correspondence and circular letters. The demand for information through these channels is constantly increasing and has become a prominent factor in the work of the Department.

List of Contributions to Premium Fund of Annual Educational Butter Scoring Contest.

Name	Amount
Ind. State Dairy Association	$ 50.00
A. H. Barber Creamery Supply Co.	10.00
Colonial Salt Co.	5.00
Chr. Hansen's Laboratory	10.00
Creamery Package Mfg. Co.	10.00
DeLaval Separator Co.	10.00
Diamond Crystal Salt Co.	10.00
J. B. Ford Co.	10.00
National Creamery Supply Co.	10.00
Sharples Separator Co.	10.00
Vermont Farm Machine Co.	10.00
Worcester Salt Co.	10.00
Creamery Journal	5.00
	$160.00

Respectfully submitted,

O. F. Hunziker,

Head of Dairy Department.

Report of the Veterinary Department.

ARTHUR GOSS, Director.

Sir:—For the year ending June 30, 1907, the work of the Veterinary Department has been conducted along the same general lines as that of last year.

The co-operative work in the treatment and control of hog cholera was the same as in former years. The results of this work demonstrated very plainly that hog cholera can be controlled when proper measures are used early in the outbreak. The difficulty in the way of controlling this disease by quarantine and hygienic measures is the indifference shown by the average stockman. In many instances met with in the field, the dead hogs were not properly disposed of and the lines of treatment recommended were carelessly carried out or neglected until the herd became badly diseased.

The symptoms and lesions occurring in many of the outbreaks resembled those of swine plague. Cultures made from the tissues of the dead animals showed that the disease was hog cholera. In this bacterial study of the disease, cultures made from the heart muscle and blood of badly diseased animals that were destroyed, frequently remained sterile.

The additional laboratory equipment and pens for inoculated and vaccinated hogs made possible lines of vaccination and inoculation work. The vaccine used was made from the tissues of rabbits that died from inoculation with the blood of a cholera hog. This vaccine has not proven altogether satisfactory. The inoculation of young hogs with filtrates from the blood of cholera hogs, has not produced the disease as uniformly as when inoculated with unfiltered blood. However, on exposure to the disease, these animals have shown immunity to a high degree. Young hogs weighing from forty to sixty pounds were used in this work.

The form of corn stalk disease prevalent in many sections of the State during the current year was the same as in former years. A number of outbreaks were investigated and a feeding experiment with moldy, rotten corn, conducted. Two healthy yearling heifers were fed from three to eight pounds, each, of spoiled corn daily for a period of twenty-six days. In addition, stover was fed. On the tenth day of the experiment, the larger heifer developed symptoms of corn stalk disease (stiffness, trembling, difficulty in getting up, slight convulsions when disturbed or slapped with the hand, etc.) Recovery occurred the following day. The corn used in this experiment came from a farm where the following interesting case of poisoning occurred: a cow ate a quantity of spoiled corn that had

been sorted from the good corn at the crib. The following afternoon the same general symptoms as noted in other outbreaks, were manifested.

Filtered bouillon (70 c. c.) on which mold from the spoiled corn had been grown for several days was injected beneath the skin of each experimental animal. No noticable symptoms occurred.

A supposed outbreak of this disease investigated was recognized as hemorrhagic septicemia. Thirteen animals in this herd were affected and two died. The two animals that died were post-mortemed. The lesions found were typical of the disease mentioned, and the specific organism (Bacterium bovisepticum) was isolated from the heart muscle.

Respectfully submitted,
R. A. Craig,
Veterinarian.

Report of Agricultural Extension Work.

Arthur Goss, Director.

Sir:—The Agricultural Extension work for the year ending June 30, 1907, has consisted largely of developing the many lines started last year. The most important of these and those receiving special attention, were the special trains, state fair exhibits, county farm tests and the organization of boys' and girls' clubs. Much time was also given to attending and lecturing before Farmers' Institutes, Farmers' Clubs, Chautauquas, and other agricultural organizations.

Special Trains.

An important part of the work done during the year was the running of several special trains. This work was accomplished through the co-operation of the various railroads with the Experiment Station.

These trains consisted of an engine, baggage car, two large audience coaches and a dining and sleeping car. The train was equipped and operated at the expense of the railroads, while the Experiment Station furnished the lecturers, and the printed literature for distribution.

Stops of about thirty minutes were made at all the important stations along the lines, and illustrated lectures were given on the harvesting, storing, selecting, testing and grading of seed corn. To assist the workers of the Experiment Station on these trips the following corn growers of the State were secured: D. F. Maish,

J. P. Davis, C. B. Benjamin, Joe Prigg, T. A. Coleman and Oliver Kline.

The roads operating the corn trains were the Lake Erie and Western; Cincinnati, Hamilton and Dayton, and Pennsylvania. The following is a summary of the work done:

RECORD OF SPECIAL CORN TRAIN WORK 1906-1907.

Railroad	Date of Train	Days occupied	Miles run	Counties visited	Stops made	Talks given	Attendance	Bulletin on corn distributed
L. E. & W..	Nov. 13 to 17, 1906	5	455	21	49	95	5000	5000
C. H. & D..	Feb. 18 to 19, 1907	2	160	10	23	48	5000	6000
Penn. Lines.	Feb. 25 to Mar. 13, 1907	15	2000	54	145	347	35000	46000
Total	....	22	2615	*85	217	490	45000	57000

*Some counties are counted twice since the various roads pass over different parts of the same county.

During the trips sixty-one counties in the corn belt of the State were visited. These counties are as follows: Adams, Allen, Bartholomew, Benton, Blackford, Carroll, Cass, Clark, Clay, Clinton, DeKalb, Delaware, Fayette, Fulton, Grant, Greene, Hamilton, Hancock, Hendricks, Henry, Howard, Jackson, Jasper, Jay, Jefferson, Jennings, Johnson, Knox, Kosciusko, LaGrange, Lake, LaPorte, Madison, Marion, Marshall, Miami, Montgomery, Morgan, Newton, Noble, Owen, Parke, Porter, Pulaski, Putnam, Randolph, Rush, Scott, Shelby, Starke, St. Joseph, Tippecanoe, Tipton, Union, Vermilion, Vigo, Wabash, Wayne, Wells, White, Whitley.

That the method of carrying information to the farmer was appreciated, was conclusively proven by the large and enthusiastic crowds that met the train at every stop. Sunshine, rain or snow, did not prevent them from being present.

The lectures were received with enthusiasm, and from reports received during the year it is believed that large numbers of the farmers followed the suggestions offered. However, it would be unfair to measure the work by this year's results alone. The farmer who adopts better methods this year is not only a better farmer himself in the future, but his methods, directly or indirectly, soon influence the entire community, and hence it is that the results cannot be measured today by bushels of corn or by millions of dollars.

County Farm Tests.

The county work started last year has been continued. Three counties, Randolph, Clinton and Hendricks, are carrying on the experiments. The work consists of a test of various varieties of corn grown by farmers in the counties in which the experiment is conducted; a test of the effect of fertilizers on corn; a comparison of hilled and drilled corn, and a study of the various rates of planting corn. This work is both interesting and valuable to the farmers of the respective counties and to the State at large. Many other counties are anxious to start work of this nature, and as far as possible the department wishes to encourage and assist this movement.

State Fair.

At the State Fair in September, 1906, an exhibit was made by the Farm Crops, Soils, Animal Husbandry, and Horticultural Departments. A booth twenty by thirty feet in the agricultural building was occupied. In the exhibit, by means of grains, fruits, soils, charts, and bromide enlargements, the work of the Station was displayed.

Much interest was shown by the visitors in this exhibit, and it undoubtedly did much to acquaint many with the work of the Experiment Station.

A special bulletin was prepared for distribution at this time. This was done with the idea of presenting the more important results of the Station work in a concise and attractive form, and of doing away with a wholesale distribution of the more expensive bulletins.

Farmers' Excursions.

On August, 9, 10, 14 and 28, LaPorte, Clinton, Hamilton and Hendricks counties, respectively, ran excursions to Purdue University and the Experiment Station. On these excursions more than 1600 farmers, their wives, sons and daughters came to the University, and spent a day visiting the buildings and laboratories, and studying the experiments in progress. Through these trips the visitors were brought into close touch with the actual work of the various departments and the men in charge. This closer relationship should mean much in the advancement of the work and for this reason similar trips from other counties should be encouraged.

Respectfully submitted,

G. I. Christie,

Superintendent Agricultural Extension.

Periodicals.

The publishers of the following periodicals have generously sent them free to the Station during the year. These are leading journals and are frequently used by all persons coming in contact with our library:

Agricultural Periodicals Donated.

Agricultural Advertising	Chicago, Ill.
Agricultural Experiments	Minneapolis, Minn.
American Agriculturalist	New York, N. Y.
American Farm World	Augusta, Me.
American Farmer	Indianapolis, Ind.
American Fertilizer	Philadelphia, Pa.
American Grange Bulletin	Cincinnati, Ohio.
American Hay, Flour and Feed Journal	New York, N. Y.
American Home Magazine	New York, N. Y.
American Poultry Advocate	Syracuse, N. Y.
American Sheep Breeder	Chicago, Ill.
American Swineherd	Chicago, Ill.
Better Fruit	Hood River, Ore.
Beet Sugar Gazette	Chicago, Ill.
Blooded Stock	Oxford, Pa.
Breeders' Gazette	Chicago, Ill.
California Cultivator	Los Angeles, Cal.
Chicago Dairy Produce	Chicago, Ill.
Chicago Live Stock World	Chicago, Ill.
Colman's Rural World	St. Louis, Mo.
Commercial Poultry	Chicago, Ill.
Cotton Seed	Atlanta, Ga.
Creamery Gazette	Des Moines, Ia.
Creamery Journal	Waterloo, Ia.
Dairy and Creamery	Chicago, Ill.
Dairy Record	St. Paul, Minn.
Dakota Farmer	Fargo, N. D.
Dakota Field and Farm	Sioux Falls, S. D.
Deutsche Americkanischer Farmer	Lincoln, Neb.
Draft Horse Journal	Chicago, Ill.
Drainage Journal	Indianapolis. Ind.
Drovers' Journal	Chicago, Ill.
Elgin Dairy Report	Elgin, Ill.
Experiment Station Record	Washington, D. C.
Fancy Fruit	North Yakima. Wash.
Farm and Fireside	Springfield, O.

Farm and Home .... Chicago, Ill.
Farm and Home Sentinel .... Indianapolis, Ind.
Farm and Live Stock Journal .... Detroit, Mich.
Farm and Stock .... St. Joseph, Mo.
Farm Folks .... Kansas City, Mo.
Farm, Garden and Poultry .... Hammonton, N. J.
Farm Home .... Springfield, Ill.
Farm Journal .... Philadelphia, Pa.
Farm Life .... Chicago, Ill.
Farm News .... Springfield, O.
Farm Poultry .... Boston, Mass.
Farm Press .... Chicago, Ill.
Farm Progress .... St. Louis, Mo.
Farm Star .... Indianapolis. Ind.
Farm, Stock and Home .... Minneapolis, Minn.
Farm Stock Journal .... Rochester, N. Y.
Farmer and Breeder .... Sioux City, Ia.
Farmers' Advance .... Chicago, Ill.
Farmers' Call .... Quincy, Ill.
Farmers' Guide .... Huntington, Ind.
Farmers' Home .... Dayton, O.
Farmers' Review .... Chicago, Ill.
Farmers' Sentinel .... Milwaukee, Wis.
Farmers' Tribune .... Sioux City, Ia.
Farming .... Chicago, Ill.
Feather .... Washington, D. C.
Field and Farm .... Denver, Colo.
Flour and Feed .... Milwaukee, Wis.
Fruit Grower .... St. Joseph, Mo.
Fruitman and Gardener .... Mt. Vernon, Ia.
Furrow .... Moline, Ill.
Garden Magazine .... New York, N. Y.
Grain Dealers' Journal .... Chicago. Ill.
Green's Fruit Grower .... Rochester, N. Y.
Hausfreund und Deutsch Americkanischer Farmer... Lincoln, Neb.
Hoard's Dairyman .... Ft. Atkinson, Wis.
Holstein-Friesian World .... Ithaca, N. Y.
Home and Farm .... Louisville, Ky.
Horticultural Visitor .... Kinmundy, Ill.
Hospodarska Listy .... Chicago, Ill.
Illuminated World Life .... Minneapolis, Minn.
Indiana Farmer .... Indianapolis, Ind.
Industrious Hen .... Knoxville, Tenn.
Inland Farmer .... Louisville, Ky.

Iowa Agriculturist .... Ames, Ia.
Iowa Homestead .... Des Moines, Ia.
Irrigation Age .... Chicago, Ill.
Jersey Bulletin .... Indianapolis, Ind.
Journal of Agriculture .... St. Louis, Mo.
Kansas Farmer .... Topeka, Kan.
Kimball's Dairy Farmer .... Waterloo, Ia.
Lewiston Inter-State News .... Lewiston, Idaho.
Lincoln Frei Presse .... Lincoln, Neb.
Live Stock and Dairy Journal .... Fresno, Cal.
Live Stock Journal .... Chicago, Ill.
Live Stock Journal .... Indianapolis, Ind.
Louisiana Planter .... New Orleans, La.
Market Growers' Journal .... Louisville, Ky.
Mennonitsche Rundschau .... Elkhart, Ind.
Missouri Agricultural College Farmer .... Columbia, Mo.
Metropolitan Rural Home .... New York, N. Y.
Modern Farmer and Busy Bee .... Eldon, Mo.
Modern Farming .... Richmond, Va.
National Farmer and Stock Grower .... St. Louis, Mo.
National Fruit Grower .... St. Joseph, Mo.
National Grange .... Philadelphia, Pa.
National Stockman and Farmer .... Pittsburg, Pa.
National Nurseryman .... Rochester, N. Y.
Nebraska Farmer .... Lincoln, Neb.
New England Farmer .... Boston, Mass.
New York Produce Review and American Creamery ....
New York, N. Y.
New York Tribune Farmer .... New York, N. Y.
Northwestern Agriculturist .... Minneapolis, Minn.
Northwest Horticulturist .... Tacoma, Wash.
Ohio Farmer .... Cleveland, O.
Orange Judd Farmer .... Chicago, Ill.
Operative Miller .... Chicago, Ill.
Oregon Agriculturist .... Portland, Ore.
Our Horticultural Visitor .... Benton Harbor, Mich.
Pacific Dairy Review .... San Francisco, Cal.
Pacific Northwest .... Portland, Ore.
Pacific Rural Press .... San Francisco, Cal.
Poultry Gazette .... Clay Center, Neb.
Poultry Husbandry .... Waterville, N. Y.
Practical Dairyman .... New York, N. Y.
Practical Farmer .... Philadelphia, Pa.
Practical Fruit Grower .... Springfield, Mo.

Prairie Farmer	Chicago, Ill.
Pure Products	New York, N. Y.
Reliable Poultry Journal	Quincy, Ill.
Rural Advocate	Battle Creek, Mich.
Rural New Yorker	New York, N. Y.
St. Louis Republic	St. Louis, Mo.
Shepherds' Criterion	Chicago, Ill.
Southern Farm Gazette	Starkville, Miss.
Southern Farm Magazine	Baltimore, Md.
Southern Planter	Richmond, Va.
Southern States	Baltimore, Md.
Southwestern Farmer and Breeder	Ft. Worth, Texas.
Strawberry	Three Rivers, Mich.
Strawberry Specialist	Kittrell, N. C.
Sugar Beet	Philadelphia, Pa.
Successful Farming	Des Moines, Ia.
Successful Poultry Journal	Chicago, Ill.
Swine Breeders' Journal	Indianapolis, Ind.
Tri-State Farmer	Chattanooga, Tenn.
Up-to-Date Farming	Indianapolis, Ind.
Wallace's Farmer	Des Moines, Ia.
Weekly News Scimitar	Memphis, Tenn.
Wisconsin Agriculturist	Racine, Wis.
Wool Markets and Sheep	Chicago, Ill.

General State Periodicals Donated.

Advertiser	Medaryville, Ind.
American Standard	Frankfort, Ind.
Banner	Bluffton, Ind.
Columbia City Mail	Columbia City, Ind.
Democrat	Salem, Ind.
Enterprise	Wolcott, Ind.
Independent	Rushville, Ind.
Kendallville News	Kendallville, Ind.
LaFayette Commercial Gazette	LaFayette, Ind.
Lowell Souvenir	Lowell, Ind.
Lyons Herald	Lyons, Ind.
Magnet	Angola, Ind.
Monterey Sun	Monterey, Ind.
News	Monon, Ind.
Progress-Examiner	Orleans, Ind.
Public Press	New Albany, Ind.
Recorder	Rising Sun, Ind.

Register ....Crown Point, Ind.
Ripley Journal ....Osgood, Ind.
Weekly Chronicle ....Plymouth, Ind.

Foreign Periodicals Donated.

Agricultural Gazette of N. S. Wales............Sidney, Australia
Co-Operative Farming ....Sussex, N. B.
Farmers' Advocate ....London, Ont.
Journal of Agriculture of Victoria ....Melbourne, Australia
Journal of the Royal Horticultural Society......London, England.
Natal Agricultural Journal and Mining Record..Maritzburg, Africa
New Zealand Dairyman and Farmers' Union Journal........
Wellington, N. Z.
Station, Farm and Dairy ....Sidney, N. S. W.
Transvaal Agricultural Journal ....Pretoria, S. Africa
Queensland Agricultural Journal ....Brisbane, Australia

Subscription Periodicals.

American Veterinary Review ....New York, N. Y.
Beihefte zun Botanischen Centralblatt ....Dresden, Germany
Berichte der Deutschen-Botanischen Gessellschaft..Berlin, Germany
Bulletin de la Societe Botanique de France..........Paris, France
Bulletin de la Societe Chemique de Paris ....Paris, France
Centralblatt fur Bakteriologie ....Jena, Germany
Chemiker Zietung ....Cothen, Germany
The Entomologist ....London, England
Gardeners' Chronicle ....London, England
Journal of Agricultural Science ....Cambridge, England
Journal of the American Chemical Society ....Easton, Pa.
Journal of Botany ....London, England
Journal of the Chemical Society ....London, England
Journal fur Landwirtschaft ....Berlin, Germany
Journal of the Royal Agricultural Society of England........
London, England
Landwirtschaftlichen Versuchs-Stationen........Berlin, Germany
Live Stock Journal ....London, England
Oil, Paint and Drug Reporter ....New York, N. Y.
Philippine Journal of Science ....Manila, P. I.
Veterinarian ....London, England
Veterinary Journal ....London, England
Zeitschrift fur Analytische Chemie ....Weisbaden, Germany
Zeitschrift fur Pflanzkrankheiten ....Stuttgart, Germany

LIST OF BULLETINS AND CIRCULARS

PUBLISHED BY

The Indiana Agricultural Experiment Station,

To January 1, 1908.

Bulletins of The School of Agriculture..

*Bulletin No. 1, January, 1885, pp. 10, pl. II. The Hessian Fly. By F. M. Webster.

*Bulletin No. 2, January, 1885, pp. 12. Experiments with nitrogenous, phosphatic and other fertilizers. By W. C. Latta.

*Bulletin No. 3, April, 1885, pp. 8, pl. III. Insects affecting growing wheat. By F. M. Webster.

*Bulletin No. 4, September, 1885, pp. 12. Experiments with wheat. By W. C. Latta.

*Bulletin No. 5, November, 1885, pp. 12, pl. II. Experiments with small fruits. By James Troop.

*Bulletin No. 6, March, 1886, pp. 16. Experiments with oats and corn. By W. C. Latta.

*Bulletin No. 7, 1886, pp. 12. Commercial fertilizers and notes on agricultural chemistry. By R. B. Warder.

*Bulletin No. 8, August 24, 1886, pp. 16. Experiments with wheat. By W. C. Latta.

*Bulletin No. 9, October 30, 1886, pp. 8, pl. I. The American Meromyza. By F. M. Webster.

*Bulletin No. 10, December 15, 1886, pp. 8. Report of the Director of the Indiana State Horticultural Experiment Station. By James Troop.

*Bulletin No. 11, 1887, pp. 4. Commercial Fertilizers. By R. B. Warder.

*Bulletin No. 12, August 25, 1887, pp. 16. Experiments with wheat. By W. C. Latta.

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Bulletins of The Purdue University Agricultural Experiment Station.

Bulletin No. 13, January, 1888, pp. 16. Report on new organization. By Pres. J. H. Smart.

Bulletin No. 14, April, 1888, pp. 20. Experiments with oats and corn. By W. C. Latta.

Bulletin No. 15, June, 1888, pp. 14, figs. 9. Concerning the potato tuber. By J. C. Arthur.

*Bulletin No. 16, August, 1888, pp. 12. Experiments with wheat. Crop rotation. By W. C. Latta.

*Bulletin No. 17, November, 1888, pp. 4. Parturient apoplexy. By T. D. Hinebauch.

Bulletin No. 18, January, 1889, pp. 12, pl. I. Experiments with vegetables. By James Troop.

*Bulletin No. 19, January, 1889, pp. 12, figs. 6. Spotting of peaches and cucumbers. By J. C. Arthur.

Bulletin No. 20, January, 1889, pp. 12, figs. 3. I. Experiments in cross fertilization. II. The culture of tropical ferns. By Pierre Van Landeghem.

Bulletin No. 21, February, 1889, pp. 16. How to feed rationally. By. C. A. Wulff.

*Bulletin No. 22, March, 1889, pp. 16. Commercial fertilizers. By H. A. Huston.

*Bulletin No. 23, April, 1889, pp. 12. Experiments with corn. By W. C. Latta.

*Bulletin No. 24, May, 1889, pp. 16, fig. I, pl. I. Experiments on milk production. By C. A. Wulff.

*Bulletin No. 25, June, 1889, pp. 18, figs. 3. Entomological experiments. By F. M. Webster.

*Bulletin No. 26, July, 1889, pp. 20, figs. 9. Wheat rust. By H. L. Bolley.

Bulletin No. 27, August, 1889, pp. 12. Field experiments with wheat. By W. C. Latta.

*Bulletin No. 28, September, 1889, pp. 24, figs. 7. Smut of wheat and oats. By J. C. Arthur.

*Bulletin No. 29, December, 1889, pp. 44, plates XIX. Grasses of Indiana. By James Troop.

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*Bulletin No. 30, February, 1890, pp. 12, figs. 2. Influenza. By T. D. Hinebauch.

*Bulletin No. 31, April, 1890, pp. 22, figs. 13. Experiments with small fruits and vegetables. By James Troop

*Bulletin No. 32, July, 1890, pp. 22. (1) Treatment of smut in wheat. By J. C. Arthur. (2) Field experiments with wheat. By W. C. Latta. (3) A note on two inferior fertilizers. By C. S. Plumb.

*Bulletin No. 33, October, 1890, pp. 23-54, fig. 1. Small fruits. By James Troop. Entomological notes. By F. M. Webster. The absorptive power of soils. By H. A. Huston and Arthur Goss.

*Bulletin No. 34, vol II, February, 1891, pp. 55-80. (1) Sugar beets. By H. A. Huston. (2) Field Experiments with commercial fertilizers and manure on barley and oats. By W. C. Latta. (3) Tests of vegetables. By James Troop.

*Bulletin No. 35, March, 1891, pp. 81-108, figs. 2-4. Loose smut of oats. By J. C. Arthur.

*Bulletin No. 36, vol. II, August, 1891, pp. 109-138. (1) Field experiments with wheat. (2) Testing grain. By W. C. Latta. (3) Wheat scab. By J. C. Arthur. (4) Forms of nitrogen for wheat. By H. A. Huston.

*Bulletin No. 37, vol. II, December, 1891, pp. 139-150. (1) Steer feeding. A comparison of cut with uncut clover. By C. S. Plumb. (2) Composition and valuation of Indiana feeding stuffs. By H. A. Huston.

*Bulletin No. 38, vol. III, March, 1892, pp. 29, plate I. (1) Small fruits. (2) Treatment of powdery mildew and black rot. (3) Vegetables. By James Troop.

*Bulletin No. 39, vol. III, April, 1892, pp. 31-62, plates II, III. (1) Field experiments with corn. By W. C. Latta. (2) Sugar beets. By H. A. Huston. (3) Diseases of the sugar beet root. By J. C. Arthur.

*Bulletin No. 40, vol. III, June, 1892, pp. 63-82, fig. 1. The silo and silage in Indiana. By C. S. Plumb.

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Bulletin No. 41, vol. III, August, 1892, pp. 83-102. (1) Field experiments with wheat. By W. C. Latta. (2) Forms of nitrogen for wheat. By H. A. Huston.

*Bulletin No. 42, vol. III, November, 1892, pp. 103-118, figs. 4. The potato: The relation of number of eyes on the seed tuber to the product. By J. C. Arthur.

*Bulletin No. 43, vol. IV, March, 1893, pp. 20. (a) Field experiments with corn. By W. C. Latta. (b) The sugar beet in Indiana. By H. A. Huston.

*Bulletin No. 44, vol. IV, May, 1893, pp. 21-44, figs. 4. Dairy experiments. By C. S. Plumb.

*Bulletin No. 45, vol. IV, August, 1893, pp. 45-65. Field experiments with wheat. By W. C. Latta. Forms of nitrogen for wheat. By H. A. Huston.

Bulletin No. 46, vol. IV, September, 1893, pp. 66-85, fig. I. (1) A modification of Grandeau's method for the determination of humus. (2) Preliminary investigation relating to the determination of "crude fibre." By H. A. Huston and W. F. McBride.

*Bulletin No. 47, vol. IV, November, 1893, pp. 86-101, figs. 2. (1) Does it pay to shelter milch cows in winter? (2) Upon skim milk as a food for calves. By C. S. Plumb.

*Bulletin No. 48, vol. V. January, 1894, pp. 14. Experiments with small fruits. By James Troop.

*Bulletin No. 49, vol. V, March, 1894, pp. 15-40, figs. 3. Sugar beets. By H. A. Huston.

*Bulletin No. 50, vol. V, April, 1894, pp. 41-56. Field experiments with corn and oats. By W. C. Latta.

*Bulletin No. 51, August, 1894, pp. 57-80. (1) Field experiments with wheat. By W. C. Latta and Geo. R. Ives. (2) Forms of nitrogen for wheat. By H. A. Huston.

*Bulletin No. 52, vol. V, November, 1894, pp, 81-113, figs. 4, plates IV. Wild or prickly lettuce. By J. C. Arthur.

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*Bulletin No. 53, vol. V, December, 1894, pp. 115-130, figs. 7, plates V, VI. Horticulture and entomology. By James Troop.

*Bulletin No. 54, vol. VI, February, 1895, pp. 8, plates II, fig. 1. New chemical apparatus. By H. A. Huston.

*Bulletin No. 55, vol. VI, March, 1895, pp. 9-56, fig. I. Experiments with small fruits. By James Troop. Experiments with corn and oats. By W. C. Latta and George R. Ives.

Bulletin No. 56, vol. VI, August, 1895, pp. 57-80. Field experiments with wheat. By W. C. Latta and S. P. Carithers. Potato scab and its prevention. By J. C. Arthur.

*Bulletin No. 57, vol. VI, November, 1895, pp. 81-100, figs. 2-6, plates III-IV. The improvement of unproductive black soil. By H. A. Huston.

*Bulletin No. 58, vol. VII, February, 1896, pp. 10. Hog cholera and swine plague in Indiana. By A. W. Bitting.

*Bulletin No. 59, vol. VII, March, 1896, pp. 11-40, plates VIII, figs. 24. Bacteriosis of carnations. By J. C. Arthur and H. L. Bolley.

*Bulletin No. 60, vol. VII, April, 1896, pp. 41-45, plates IX-XIV, figs. 25-31. The American persimmon. By James Troop and O. M. Hadley.

*Bulletin No. 61, vol. VII, August, 1896, pp. 55-70. Field experiments with wheat. By W. C. Latta and W. B. Anderson.

*Bulletin No. 62, vol. VII, October, 1896, pp. 71-96, figs. 32-42. The udder of the cow. By C. S. Plumb.

*Bulletin No. 63, vol. VII, December, 1896, pp. 97-116, plates XV-XVI. Bovine tuberculosis in Indiana. By A. W. Bitting.

*Bulletin No. 64, vol. VIII, April, 1897, pp. 16. Field experiments with corn, oats and forage plants. By W. C. Latta and W. B. Anderson.

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*Supply exhausted.

*Bulletin No. 65, vol. VIII, June, 1897, pp. 17-36, plates II. Formalin for prevention of potato scab. By J. C. Arthur.

Bulletin No. 66, vol. VIII, October, 1897, pp. 37-60, plates III and IV, fig. 1. Indoor lettuce culture. By William Stuart. Condensed edition also, 8 pp.

*Bulletin No. 67, vol. VIII, December, 1897, pp. 61-70. Wheat and corn as food for pigs. C. S. Plumb and W. B. Anderson.

Bulletin No. 68, vol. IX, March, 1898, pp. 32, figs. 13. The sugar beet in Indiana. By H. A. Huston and J. M. Barrett.

*Bulletin No. 69, vol. IX, March, 1898, pp. 33-40. Insecticides, fungicides and spraying. By James Troop.

*Bulletin No. 70, vol. IX, 1898, pp. 41-52, figs. 14-16. The relation of water supply to animal diseases. By A. W. Bitting.

*Bulletin No. 71, vol. IX, June, 1898, pp. 53-64. I. Corn meal and shorts as food for pigs. By C. S. Plumb and W. B. Anderson. II. Skim-milk as food for young chickens. By W. B. Anderson.

Bulletin No. 72, vol. IX, August, 1898, pp. 65-76. Field experiments with wheat. By W. C. Latta and W. B. Anderson.

Bulletin No. 73, vol. IX, October, 1898, pp. 77-92, figs. 17-19. Tests of strawberries, raspberries, blackberries, grapes. By James Troop.

Bulletin No. 74, vol. IX, November, 1898, pp. 93-100, figs. 20, plates I-VI. A native white bedding plant. By J. C. Arthur.

*Bulletin No. 75, vol. X, January, 1899, pp. 1-20, fig. 1. The sugar beet in Indiana in 1898. By H. A. Huston and A. H. Bryan.

*Bulletin No. 76, vol. X, March, 1899, pp. 21-28. Skim milk as a food for young growing chickens. By W. B. Anderson.

Bulletin No. 77, vol. X, March, 1899, pp. 29-44. Field experiments with corn. By W. C. Latta and W. B. Anderson.

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*Bulletin No. 78, vol. X, May, 1899, pp. 45-52, figs. 2-4. The San Jose and other scale insects, and the Indiana nursery inspection law. By James Troop.

Bulletin No. 79, vol. X, June, 1899, pp. 53-62. Roots as food for pigs. By C. S. Plumb and H. E. Van Norman.

Bulletin No. 80, vol. X, September, 1899, pp. 63-76, figs. 5-12. Sheep scab. By A. W. Bitting.

Bulletin No. 81, vol. X, December, 1889, pp. 77-92. Field tests with fertilizers on heavy clay lands. By H. A. Huston.

Bulletin No. 82, vol. X, March, 1900, pp. 93-106. Roots and other succulent foods for swine. By C. S. Plumb.

Bulletin No. 83, vol. X, August, 1900, pp. 107-114. Test of small fruits. By James Troop.

Bulletin No. 84, vol. X, September, 1900, pp. 115-142, plates III, graphic charts III. Growing lettuce with chemical fertilizers. By William Stuart.

Bulletin No. 85, vol. X, October, 1900, pp. 143-150. Chrysanthemum rust. By J. C. Arthur.

Bulletin No. 86, vol. X, December, 1900, pp. 151-158. On the amount of water in slop fed fattening pigs. By C. S. Plumb and H. E. Van Norman.

Bulletin No. 87, vol. XI, March, 1901, pp. 1-26. Formalin as a preventive of oat smut. By William Stuart.

Bulletin No. 88, vol. XI, March, 1901, pp. 27-38. Systems of cropping with and without fertilization. By W. C. Latta and J. H. Skinner.

Bulletin No. 89, vol. XI, July, 1901, pp. 39-69. The production and delivery of milk in cities. By A. W. Bitting.

Bulletin No. 90, vol. XI, October, 1901, pp. 70-82. Tankage as a food for pigs. By C. S. Plumb and H. E. Van Norman.

Bulletin No. 91, vol. XI, January, 1902, pp. 83-106, fig. 2-5. The modern silo. By C. S. Plumb.

Bulletin No. 92, vol. XI, April, 1902, pp. 101-116. Fertilizer tests on tomatoes. By H. A. Huston.

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Bulletin No. 93, vol. XI, June, 1902, pp. 117-123. The influence of condimental stock food in fattening swine. By C. S. Plumb.

Bulletin No. 94, vol. XII, February, 1903, pp. 1-88, illustrations 15. Diseases of sheep. By A. W. Bitting and R. A. Craig.

Bulletin No. 95, vol. XII, March, 1903, pp. 1-31, plates I-IV, figs. 1-5. The improvement of unproductive black soils. By H. A. Huston.

*Bulletin No. 96, vol. XII, July, 1903, pp. 1-36, figs. 1-8. The care of milk and butter making on the farm. By H. E. VanNorman.

Bulletin No. 97, vol. XII, October, 1903, pp. 37-42. On the value of distillery dried grains as a food for work horses. By C. S. Plumb.

Bulletin No. 98, Vol. XII, January, 1904, pp. 43-56, fig. 1, plates I-VI. Three edible toadstools. By J. C. Arthur.

Bulletin No. 99, vol. XII, March, 1904, pp. 57-68. Tests of small fruits. By James Troop.

*Bulletin No. 100, vol. XII, September 1904, pp. 69-204, illustrations 23. Diseases of swine. By R. A. Craig and A. W. Bitting.

Bulletin No. 101, vol. XII, February, 1905, pp. 205-219. Alfalfa in Indiana. By A. T. Wiancko and M. L. Fisher.

Bulletin No. 102, vol. XII, March, 1905, pp. 220-254, illustrations 8. Apple growing in Indiana. By J. Troop.

Bulletin No. 103, vol. XII, March, 1905, pp. 255-264. Rapid method of removing smut from seed oats. By J. C. Arthur.

*Bulletin No. 104, vol. XII, March, 1905, pp. 265-274, illustrations 2. A simple alkali test for ripeness of cream. By H. E. VanNorman.

*Bulletin No. 105, vol. XII, March, 1905, pp. 275-322, illustrations 14. Corn improvement in Indiana. By A. T. Wiancko.

*Bulletin No. 106, vol. XII, May, 1905, pp. 52, maps 1. Commercial fertilizers. By Arthur Goss and W. J. Jones, Jr.

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Bulletin No. 107, vol. XIII, July, 1905, pp. 12. Agriculture at Purdue University. By Pres. W. E. Stone.

Bulletin No. 108, vol. XIII, July, 1905, pp. 13-32, illustrations 4. Soy beans, middlings and tankage, as supplemental feeds in pork production. By J. H. Skinner.

Bulletin No. 109, vol. XIII, November, 1905, pp. 33-76, illustrations 28. Examinations of horses for soundness. By A. W. Bitting and G. H. Roberts.

*Bulletin No. 110, vol. XIII, January, 1906, pp. 77-120, illustrations 15. Corn improvement. By A. T. Wiancko.

Bulletin No. 111, vol. XIII, March, 1906, pp. 121-134. Indiana plant diseases in 1905. By Frank D. Kern.

Bulletin No. 112, vol. XIII, April, 1906, pp. 135-208, maps 1. Commercial fertilizers. By Arthur Goss and W. J. Jones, Jr.

Bulletin No. 113, vol. XIII, June, 1906, pp. 208-288, illustrations 20. Characteristics of some of the contagious and infectious stock diseases. By A. W. Bitting and G. H. Roberts.

Bulletin No. 114, vol. XIII, August, 1906, pp. 289-308, illustrations 1. Winter wheat. By A. T. Wiancko and M. L. Fisher.

Bulletin No. 115, vol. XIII, December, 1906, pp. 309-337, illustrations 7. Steer feeding. By J. H. Skinner and W. A. Cochel.

Bulletin No. 116, vol. XIII, December, 1906, pp. 338-364, illustrations 11. The hand separator and the gravity systems of creaming. By O. F. Hunziker.

Bulletin No. 117, vol. XIII, February, 1907, pp. 365-394, maps 1. Results of co-operative tests of varieties of corn, wheat, oats, soy beans and cow peas. By A. T. Wiancko.

Bulletin No. 118, vol. XIII, March, 1907, pp. 395-423, illustrations 14. How to control the San Jose scale and other orchard pests. By James Troop and C. G. Woodbury.

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Bulletin No. 119, vol. XIII, March, 1907, pp. 424-436, illustrations 1. Indiana plant diseases in 1906. By Frank D. Kern.

Bulletin No. 120, vol. XIII, March, 1907, pp. 437-460, illustrations 7. Soy beans, cow peas and other forage crops. By A. T. Wiancko and M. L. Fisher.

Bulletin No. 121, vol. XIII, May, 1907, pp. 461-538, maps 1. Commercial fertilizers. By W. J. Jones, Jr. and O. C. Haworth.

Bulletin No. 122, vol. XIII, June, 1907, pp. 539-554. Alfalfa in Indiana. By A. T. Wiancko.

Circulars.

No. 1. October, 1906, pp.1-13, illustrations 2. Hints on preparing for and holding local corn shows. By A. T. Wiancko and M. L. Fisher.

No. 2. November, 1906, pp. 1-14, illustrations 10. The selection, preservation and preparation of seed corn. By A. T. Wiancko and G. I. Christie.

No. 3. December, 1906, pp. 1-10. Corn stalk disease. By R. A. Craig.

No. 4. January, 1907, pp. 1-10, illustrations 5. The Experiment Station building. By Arthur Goss.

No. 5. December, 1906, pp. 1-4. Report of experimental work on the Randolph county farm. By G. I. Christie.

No. 6. April, 1907, pp. 1-10. The feeding stuff control law. By Arthur Goss and W. J. Jones, Jr.

No. 7. April, 1907, pp. 1-14. Additional information concerning the feeding stuff control law. By Arthur Goss and W. J. Jones, Jr.

No. 8. October, 1907, pp. 1-8. Beef production. I. Purchasing feeders. By J. H. Skinner and W. A. Cochel.

No. 9. November, 1907, pp. 1-11, illustrations 6. Commercial fruit growing. By James Troop and C. G. Woodbury.

No. 10. November, 1907, pp. 1-16, illustrations 3. The use of fertilizers on southern Indiana soils. By Arthur Goss.

No. 11. December, 1907, pp. 1-8, illustrations 4. Milk production. 1. Herd improvement. By Herbert A. Hopper.

FINANCIAL STATEMENT.

Treasurer's Report.

Receipts for Experiment Station Funds:

Balance from Miscellaneous fund, June 30, 1906	$ 2,079.74
From United States Treasurer for year ending June 30, 1907, Hatch fund	15,000.00
From United States Treasurer for year ending June 30, 1907, Adams fund	7,000.00
From State Treasurer, for year ending Sept. 30, 1907	22,916.67
From Miscellaneous receipts, for year ending June 30, 1907	23,071.91
Total	$70,068.32

James M. Fowler,
Treasurer Board of Trustees.

Secretary's Report.

Government Hatch Fund, for the Year Ending June 30, 1907.

	Dr.	Cr.
Received from U. S. Treasurer	$15,000.00	
Salaries		$ 8,675.44
Labor		2,207.30
Publications		1,546.02
Postage and stationery		485.35
Freight and express		86.81
Heat, light, water and power		60.27
Chemical supplies		96.55
Seeds, plants and sundry supplies		463.28
Fertilizers		.00
Feeding stuffs		.00
Library		214.68
Tools, implements and machinery		158.59
Furniture and fixtures		47.20
Scientific apparatus		166.50
Live stock		.00
Traveling expenses		548.66
Contingent expenses		.00
Buildings and repairs		243.35
Total	$15,000.00	$15,000.00

Government Adams Fund, for the Year Ending June 30, 1907.

	Dr.	Cr.
Received from U. S. Treasurer - -	$ 7,000.00	
Salaries - - - - - - -		2,938.19
Labor - - - - - - - -		38.75
Publications - - - - - - -		.00
Postage and stationery - - -		.38
Freight and express - - - -		6.69
Heat, light, water and power - -		.00
Chemical supplies - - - - - -		1,286.24
Seeds, plants and sundry supplies -		203.33
Fertilizers - - - - - - -		.00
Feeding stuffs - - - - - -		5.00
Library - - - - - - - -		502.58
Tools, implements and machinery -		47.40
Furniture and fixtures - - - -		.00
Scientific apparatus - - - - -		1,468.14
Live stock - - - - - - -		234.50
Traveling expenses - - - - -		251.00
Contingent expenses - - - -		.00
Buildings and repairs - - - - -		17.80
Total - - - - - - -	$ 7,000.00	$ 7,000.00

State Agricultural Experiment Fund for the Year Ending September 30, 1907.*

	Dr.	Cr.	
Rec'd from the State Treasurer..	$22,916.67		
General			
Salaries		$2,561.45	
Labor		159.99	
Publications		1,323.47	
Postage, stationery and printing.		904.12	
Freight, express and drayage....		141.64	
Chemical supplies		121.30	
Seeds, plants and sundry supplies		415.60	
Feeding stuffs		.00	
Library		453.27	
Tools, implements and machinery		330.04	
Furniture and fixtures		514.95	
Scientific apparatus		56.50	
Live stock		1,440.15	
Traveling expenses		492.86	
Contingent expenses		10.47	
Buildings and repairs		3.50	
Fertilizers		31.56	
Exhibit State Fair		205.81	
			$ 9,166.68
Live Stock Feeding			
Salaries		$1,155.29	
Labor		88.85	
Postage, stationery and printing. .		25.50	
Freight and express		344.31	
Seeds, plants and sundry supplies		319.24	
Feeding stuffs		1,150.69	
Tools, implements and machinery		18.25	
Furniture and fixtures		.00	
Live stock		1,036.05	
Traveling expenses		360.01	
Contingent expenses		5.15	
Buildings and repairs		77.04	
Chemical supplies		2.95	
			$ 4,583.33
Carried forward	$22,916.67		$13,750.01

*As the end of the State fiscal year was changed from October 31 to September 30, this report covers but eleven months.

State Agricultural Experiment Fund for the Year Ending September 30, 1907.—Continued.

	Dr.	Cr.	
Brought forward	$22,916.67		$13,750.01
Dairy Interests			
Salaries		$ 1,833.31	
Labor		61.45	
Postage and Stationery		181.23	
Freight and express		156.54	
Chemical supplies		84.24	
Seeds, plants and sundry supplies		575.66	
Furniture and fixtures		206.30	
Scientific apparatus		164.60	
Traveling expenses		1,050.99	
Contingent expenses		18.81	
Buildings and repairs		4.70	
Tools and machinery		81.00	
Publications		164.50	
			$ 4,583.33
Crop and Soil Improvement			
Salaries		$ 1,370.77	
Labor		526.71	
Postage, stationery and printing		112.91	
Freight and express		371.12	
Chemical supplies		4.25	
Seeds, plants and sundry supplies		696.42	
Tools, implements and machinery		5.00	
Furniture and fixtures		40.75	
Scientific apparatus		.00	
Traveling expenses		993.35	
Contingent expenses		16.26	
Buildings and repairs		19.87	
Fertilizers		165.00	
Exhibit State Fair		154.16	
Publications		99.76	
Library		7.00	
			$ 4,583.33
Total	$22,916.67		$22,916.67

Miscellaneous Fund, for the Year Ending June 30, 1907.
(Derived from farm sales, fertilizer inspection fees, etc.)

	Dr.	Cr.
Balance June 30, 1906	$ 2,079.74	
Total receipts for year	23,071.91	
Salaries		$ 7,699.61
Labor		1,931.58
Publications		1,251.70
Postage		117.62
Stationery and printing		2,041.65
Freight and express		139.65
Heat, light, water and power		974.54
Chemical supplies		526.01
Seeds, plants and sundry supplies		774.41
Fertilizers		.50
Feeding stuffs		860.91
Library		1.50
Tools, implements and machinery		2.44
Furniture and fixtures		199.20
Scientific apparatus		85.20
Live stock		2,831.25
Traveling expenses		1,529.24
Contingent expenses		164.00
Buildings and repairs		5.80
Balance		4,014.75
Total	$25,151.65	$25,151.65

Summary of Total Receipts and Expenditures of the Station.

Hatch, Adams and Miscellaneous Funds for the Year Ending June 30, 1907; State Agricultural Experiment Fund for the Year Ending Sept. 30, 1907.

	Dr.	Cr.
Balance from year previous - - - -	$ 2,079.74	
Rec'd from U. S. Gov. Hatch fund -	15,000.00	
Rec'd from U. S. Gov. Adams fund -	7,000.00	
Rec'd from State Agricultural Experiment fund - - - - - - -	22,916.67	
Other receipts, Miscellaneous fund -	23,071.91	
Salaries - - - - - - -		$26,234.06
Labor - - - - - - - -		5,014.63
Publications - - - - - -		4,385.45
Postage and stationery - - - -		3,868.76
Freight and express - - - - -		1,246.76
Heat, light, water and power - -		1,034.81
Chemical supplies - - - - -		2,121.54
Seeds, plants and sundry supplies - -		3,447.94
Fertilizers - - - - - - -		197.06
Feeding stuffs - - - - - -		2,016.60
Library - - - - - - -		1,179.03
Tools, implements and machinery - -		642.72
Furniture and fixtures - - - -		1,008.40
Scientific apparatus - - - - -		1,940.94
Live stock - - - - - -		5,541.95
Traveling expenses - - - - -		5,226.11
Contingent expenses - - - - -		214.78
Buildings and repairs - - - - -		372.06
Exhibit State Fair - - - - -		359.97
Balance - - - - - - -		4,014.75
Total - - - - - - -	$70,068.32	$70,068.32

The foregoing is a correct statement of expenditures from the the Hatch, Adams and Miscellaneous funds for the year ending June 30, 1907, and from the State Agricultural Experiment Fund for the year ending Sept. 30, 1907.

Edward A. Ellsworth,

Secretary Board of Trustees.